A SYSTEM

OF

ELECTROTHERAPEUTICS

INTERNATIONAL CORRESPONDENCE SCHOOLS
SCRANTON, PA.

ELECTRICITY IN DISEASES OF THE EYE, EAR, NOSE, AND THROAT

ELECTRICITY IN GENITO-URINARY DISEASES

THERAPEUTICS OF STATIC ELECTRICITY

ELECTRICITY IN DENTISTRY

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Electricity in Diseases of the Eye, Ear, Nose, and Throat

INTRODUCTION

1. If the century just passed has signalized no great discovery or achievement beyond the recognition of the principles of electricity and their development, that era might justly be written down the "golden age." The quantity of research stimulated by the labors of Volta and Galvani has been enormous and the results have surpassed the highest expectations of man.

It is a strange truth that genius is the product of a fostering parent—time. At certain periods there are born a troop of masters who rule the intellectual world for a lifetime and then pass beyond, leaving for their underlings a lapse to be utilized in the learning and appreciation of their works.

At the close of the 18th and beginning of the 19th century there were Humboldt, Davy, Ampere, and Faraday, scientists and philosophers; Goethe, Coleridge, and Byron illumined the literary sphere; Bach, Beethoven, and Mozart filled the earth with purest melody. These men were but few of that great academy of poets, philosophers, and scientists. We are watching now the first gray streaks of the dawn of a new cycle. It is not beyond the bounds of prediction to say that we shall soon listen to the teachings of new masters and catch the flash of jewels, brighter and more luminous than the old, in the crowns of genius. The age is ripe for a new array of giants. There is needed a skilful hand to collect the good and useful and throw out what is indifferent; a master mind to classify and arrange our varied stores of knowledge. Our vast library needs to be recatalogued.

2. In the new order of things there should be some impetus which shall lead us to a fair and comprehensive study of facts; which shall help us to a fair and impartial judgment. We are prone, it is feared, to condemn and lay aside the things which we little understand. The common fate of every prophesy is ridicule and unbelief, simply from the fact that what is told is beyond our ken or without our understanding. Those of us who have four decades only to our credit may remember with what reserve were accepted those valuable instruments of utility—the telephone and the electric light. Many a man of business refused to avail himself of the advantages a telephone affords until he saw his more progressive competitor surpass him in the footings of his day-book. The electric light was regarded as an illumination too bright for normal eyes. Many a farmer was prone to swing the cradle and bind his grain by hand long after he might have profited by the use of the self-binder.

In education, as well, the truth applies. Have we not heard of the instructor who awakens to find himself deprived of his charge because he was not abreast of more progressive methods? The practice of law has undergone radical changes in late years, so that there now exists the specialist in copyright law, in banking law, in the law as it relates to patent rights, and in many particular divisions of the whole. The man of today who would follow the old teachers and aim to be a general practitioner will find the rocks of adversity ahead.

3. In no profession or walk in life, perhaps, is the necessity for broad-minded consideration and liberal study so imperative as that of the practice of medicine. The physician has moral responsibilities greater than his coworkers in other lines. He deals with the principles of life itself where others traffic in its products.

The specialist is the logical outcome of study and environment. He is trained by the demands of his practice. It is but natural that the individual who has particular advantages for the observation and study of one thing, be that what it may, should know more about it than he who merely reads or casually takes notice. It is not our intention to plead for specialism, but it *is*

our wish to plead for a broader and more generous recognition of the truths that specialists have demonstrated. Let us at least give trial before we condemn, before we accept. The celebrated reply of John Hunter to his student, who said he *thought*, was "Do not think, work!" The French philosophers confronted Franklin with the question whether the fish, thrown into the bucket of water, would add to the water's weight. "Let us try the experiment," said the philosopher.

4. Electricity in therapeutics is a scientific entity and its application an art. If one were to build a bridge or construct a locomotive, he must follow the exact principles of engineering and mechanics. If a surveyor would lay out a road, his plans must be mathematically correct or his grade will be faulty. So, too, in electrotherapeutics, the operator must work according to fixed and well-established laws, and his instruments and appliances must be constructed after most precise plans.

For many years the very word electricity was synonymous with mysticism; this was no doubt due to the fact that the rudiments of the science were known to charlatans and made use of by them in a way to startle and beguile the people. When Franklin drew lightning from the clouds and thereby revolutionized the theories of his day, the mass of people associated electricity with tempests and the supernatural. But though these factors have caused damage to a measure, they have stimulated research as well. Many of the foremost of our scientists have devoted their intellectual wealth to the study of the science with the result of firmly establishing it as an exact science, and our best workers in medicine, many of them, have taught us the definite and invariable principles of the art.

With these principles before us we have all the materials for the experiment. Why do we not try it? The reason is partly to be found in the shortcomings of our medical schools as regards instruction in electrophysics. This portion of the curriculum is neglected sadly. Some of our leading colleges offer courses in electrotherapeutics and electrophysics, but many students are deprived of these advantages. The practitioner, if he be a busy one, must acquire this learning as best he may, or not at all.

To the students and practitioners who have taken the lessons in electro-physics preparatory to instruction in electro-therapeutics, let us say that these lessons are of inestimable value, partly because they embrace all that is essential for a working knowledge, and partly because the unnecessary elements, which would tend to confuse, have been eliminated.

5. The specialist in medicine, in whatsoever field he may be working, cannot afford to ignore the value of electricity as one of his therapeutic resources. There are certain ends it will bring about and certain results it will offer that no other agent can reproduce. It will by no means accomplish everything, even though the principles be correctly applied, and it certainly will yield nothing if they be wrongly or carelessly put to use.

For many years electricity has been used in the treatment of some of the diseases of the eye, ear, nose, and throat. Much has been written upon the subject by workers in every country, and hundreds of cases have been reported showing the beneficial effects of various currents properly applied. In spite of all that has been done and written, we search the modern text-books well nigh in vain for enlightenment on the subject. Some authors barely mention electrical treatment, while others frankly state that they have had no personal experience with its application. Whether these conditions arise from a lack of appreciation, from an aversion, or from a lack of study, it is hard to say. Be this as it may, the fact remains that the student derives little benefit from the usual sources, and must needs seek his knowledge elsewhere.

Many of the affections of the eye and upper respiratory passages are amenable to treatment by the various forms of electricity, and in some conditions electrical treatment is the rational procedure par excellence, and will accomplish what nothing else will. With these ideas well in mind we shall turn our attention to the consideration of the application of electricity in diseases of the eye, ear, nose, and throat. We shall make use of galvanism, or direct currents, faradism, or induced currents, electric light, the electrocautery, magnetism, electrolysis, cataphoresis, and Roentgen rays.

The principles of these forms of electric energy are now well understood by the student, and it remains to demonstrate their appropriate selection and application.

Before beginning a consideration of the various diseases and their treatment, we shall devote some time to the various instruments and appliances necessary and useful to the work.

ESSENTIAL APPARATUS

6. Source of Current.—The current requisite for all practical applications of galvanism, faradization, and electrolysis may be obtained in a variety of ways. In cities where

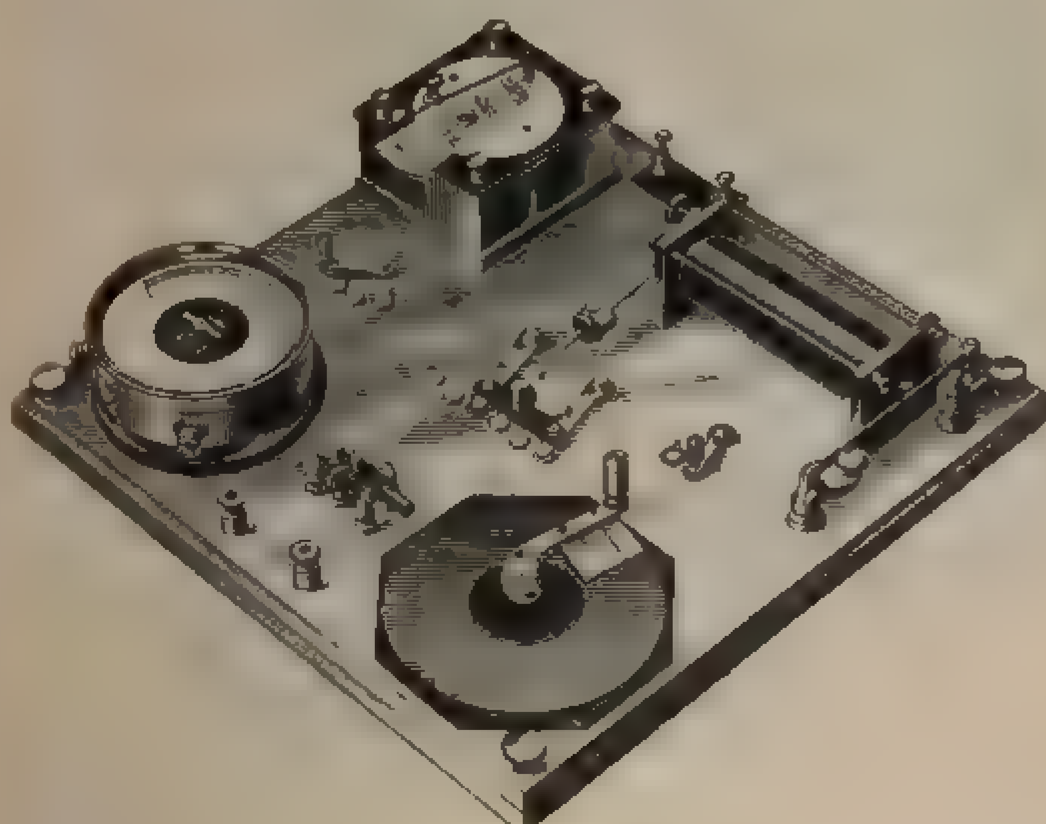

FIG. 1

Table-Plate

the ordinary 55- or 110-volt constant current for incandescent lighting is available, this will be found very serviceable and convenient. The currents of high voltage in street-car and arc-lighting circuits are dangerous, and should not be used. Some lighting companies will furnish *power*, as it is called, which is generally a constant current of 100 volts or over. If

the practitioner is unable to obtain either of these sources of energy, he has still several resources. A battery of cells may be used. These cells may be of any desired pattern, but the ordinary "sal-ammoniac" cells will be found as satisfactory as any. These should be mounted upon shelves in a convenient place in the physician's office, or arranged in a cupboard or beneath a table. This battery should contain from thirty to fifty cells connected *in series*. The terminal wires should be connected to binding-posts so situated as to be within easy reach of

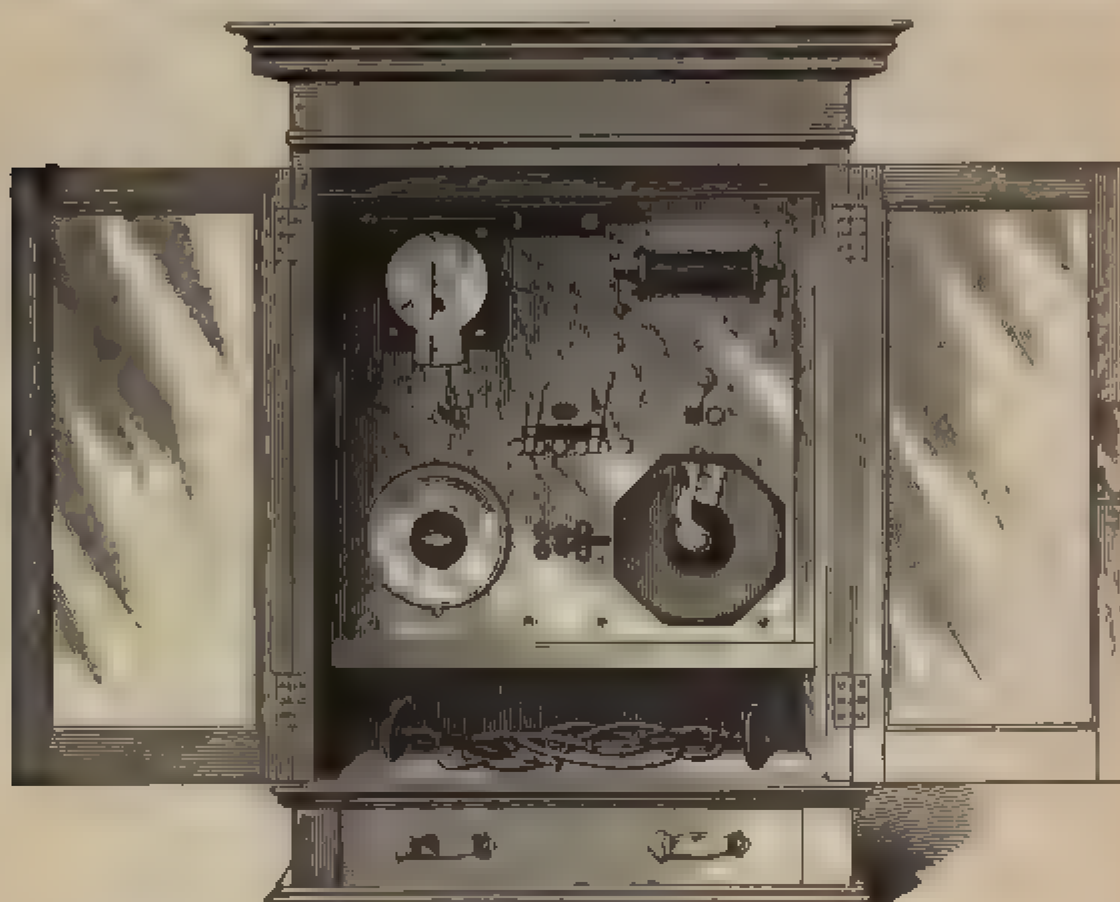

FIG. 2
Wall Cabinet

the operator's hand. The terminals may be connected to the proper posts on a table-plate, Fig 1. Where a wall cabinet, Fig. 2, can be afforded, in the lower shelves of which the jars are stored, the arrangement will prove very compact and convenient. The fluid batteries occasion some annoyance at times on account of leakage and corrosion, particularly in the cells of the bichromate type. Some operators have discarded them entirely because of the care they require. The general

objections to fluid batteries may be met by substituting *dry cells*, of which there are several patterns. The silver-chlorid cells are much used. They are portable and, with ordinary handling, unbreakable.

7. Control of Electric Current.—We have thus far considered the sources of the current only. How shall it be controlled and measured to suit the individual cases? Let us suppose we are using the current from the incandescent-light

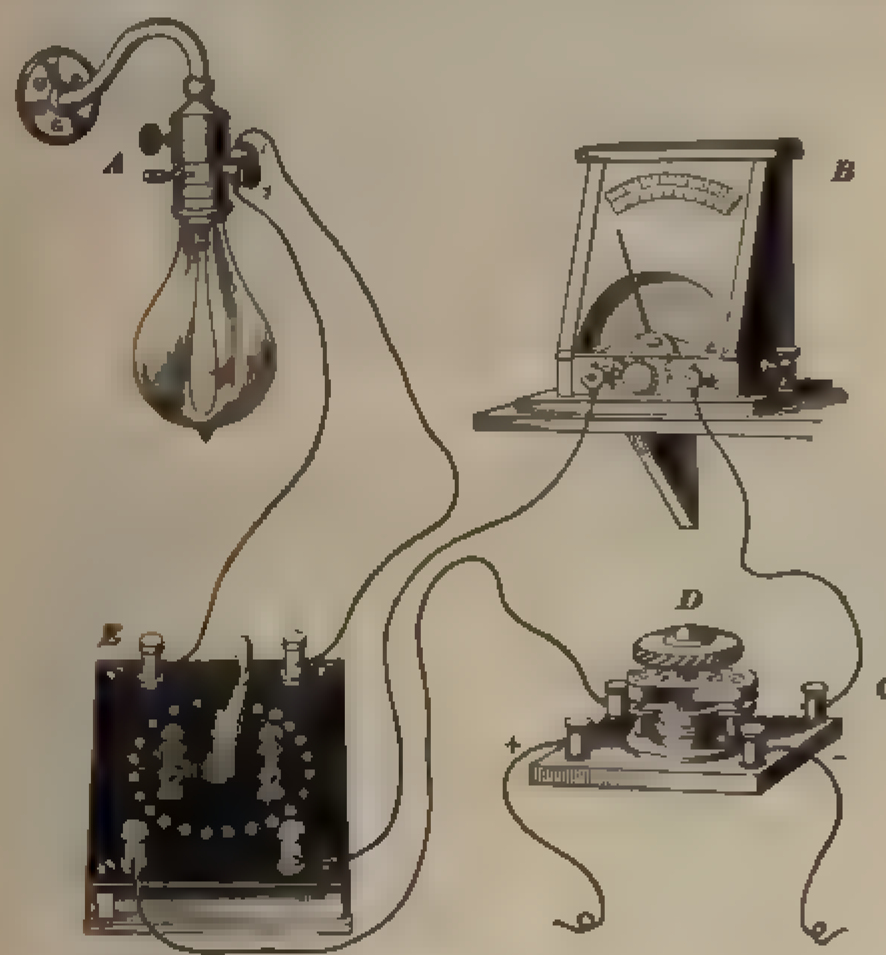

FIG. 3
Scheme for Utilizing the Current of an Incandescent Light Circuit

circuit, the voltage of which is 110. Fig. 3 illustrates a scheme of adaptation. *A* is a current-adapter, which is inserted into the ordinary light-socket and brings a lamp into series, thus limiting the current to about $\frac{1}{2}$ ampere. *1* and *2* are binding-posts from which wires pass to posts in *E*, which is an instrument known as a *selector*. By this contrivance any voltage from 1 to 110 may be obtained. In the circuit passing from *E* to

the patient are two appliances, *B*, a milliamperemeter, or milliammeter, which bears a direct reading or absolute scale, and indicates the exact amount of current passing, and *C*, a current-controller, or rheostat of carbon. By turning the thumbscrew *D*, the finest gradations of current may be made, even to fractions of a milliampere. Any arrangement of the apparatus will suffice so long as a rheostat and a milliammeter are always in the circuit. Interrupters, pole-changers, and induction-coils may be placed in circuit as needed Many of the table-plates

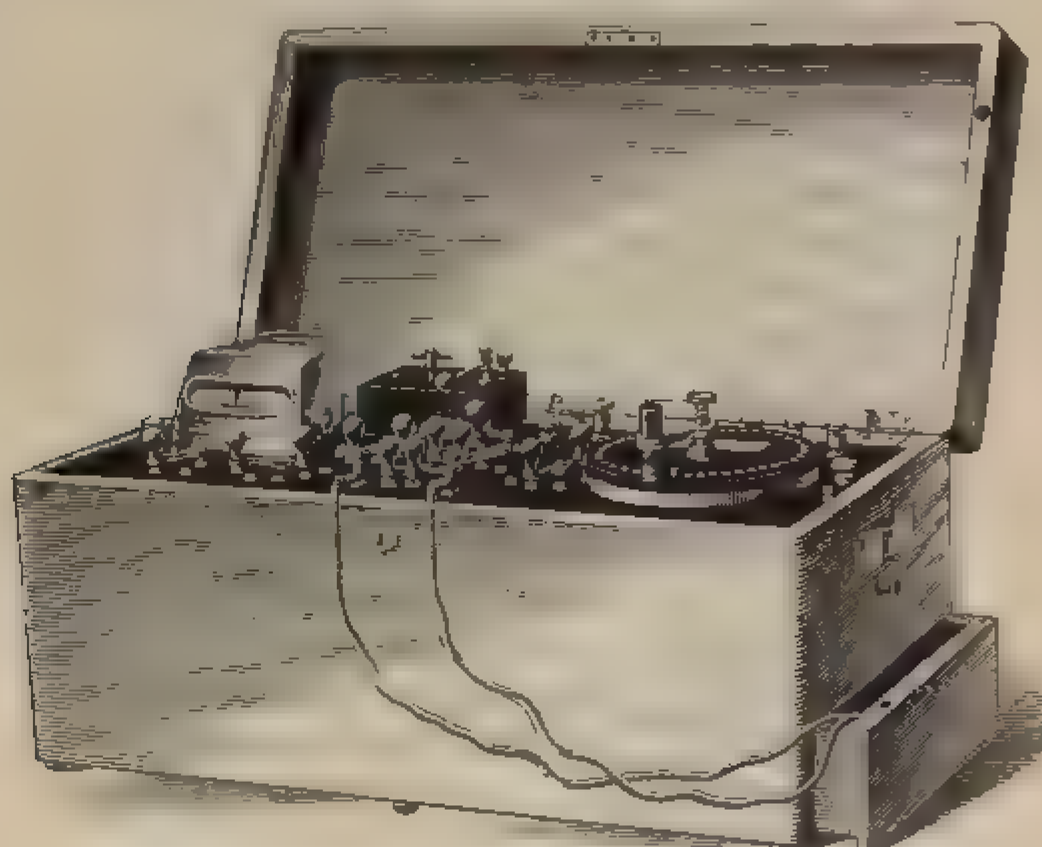

FIG. 4

A Convenient Form of Dry-Cell Battery

and wall cabinets contain all these accessories A most convenient variety of dry-cell battery for general work is shown in Fig. 4 (see Art. **50**, *Direct Currents*), wherein all essentials are arranged in a compact space A very desirable rheostat (see Art. **25**, *Essential Apparatus*) is shown in Fig 5. This instrument furnishes the scale of resistances in ohms on its face It may be used either with the galvanic current or the induction-coil. Fig 6 shows another form of rheostat. Liquid rheostats

are shown in Figs. 23 and 24, *Essential Apparatus*. Fig. 7 illustrates a convenient milliammeter (see Art. 11, *Essential Apparatus*). It must not be supposed, however, that costly

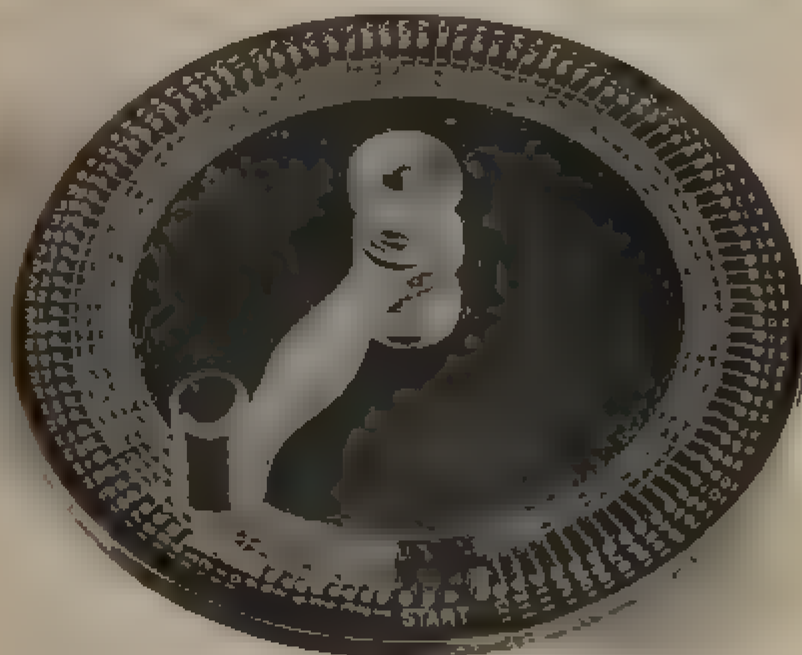

FIG. 5
A Direct-Reading Rheostat

apparatus and appliances are necessary for successful work to be done. An ingenious workman may arrange at very

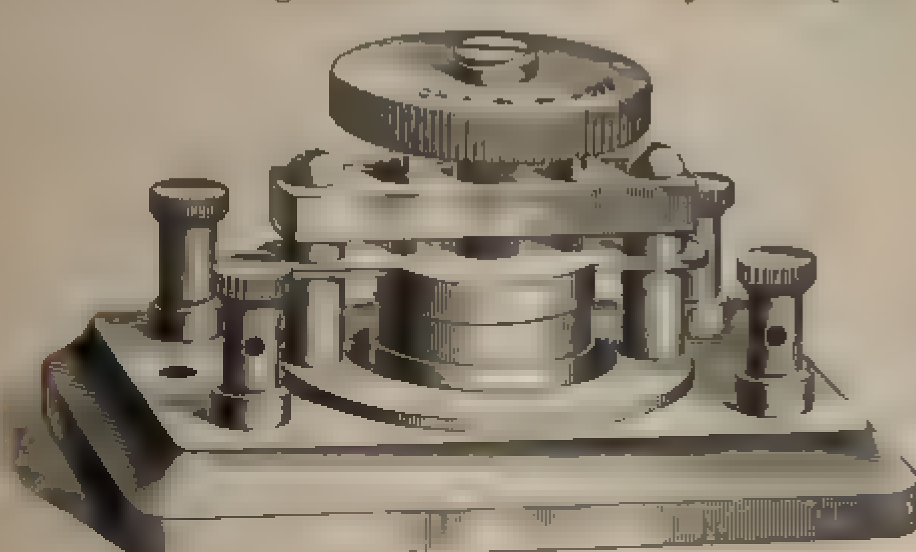

FIG. 6
Another Type of Rheostat

trifling expense an apparatus suitable for office-work. For instance, a battery may be made of cells made from ordinary tin cans, iron filings, a few porous cups, and carbon points

Such a cell is shown in Fig. 8. A home-made rheostat consists of a U-shaped tube of glass and a wire plunger and spring, as shown in Fig. 9. We have used such apparatus and found it very serviceable.

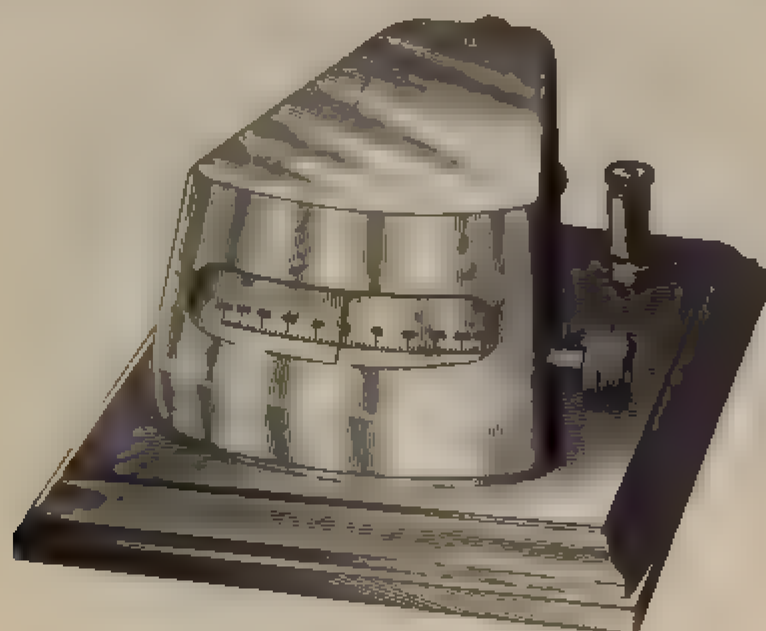

Fig. 7
A Convenient Milliammeter

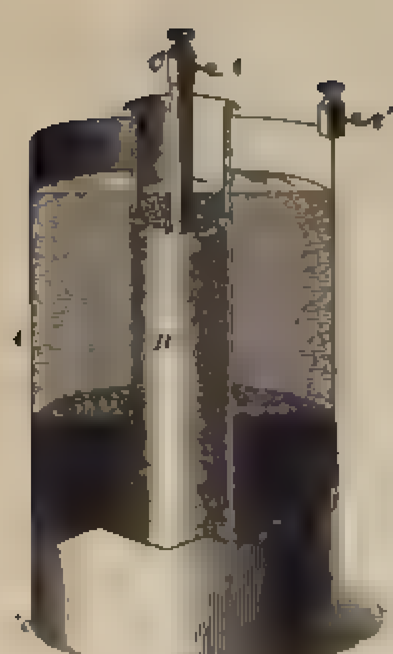

Fig. 8
A Cheap, Home-Made Battery

8. Electric Needles, Handles, Etc.—In the selection of electrolytic needles, handles, and electrodes, the physician should avail himself of the best only. Needles should be of gold, platinum, or, preferably, iridoplatinum. Such needles do not corrode or oxidize. They may be insulated according to the use for which they are intended. The selection of various styles of handles and electrodes is a matter of preference with the physician. The cords, connections, and binding-posts should be of the best quality (see Fig. 10). Test them thoroughly before using. Many of the electrodes designed for special use will be described as occasion arises for their use. Where simple galvanism is to be administered the electrode may often

consist of a piece of clean copper wire or a probe, wrapped with absorbent cotton that has been moistened with a salt-solution consisting of 1 dram of common salt to 1 pint of distilled water. Cataphoresis requires special electrodes made of different materials, such as pure copper or zinc. These will be spoken of later.

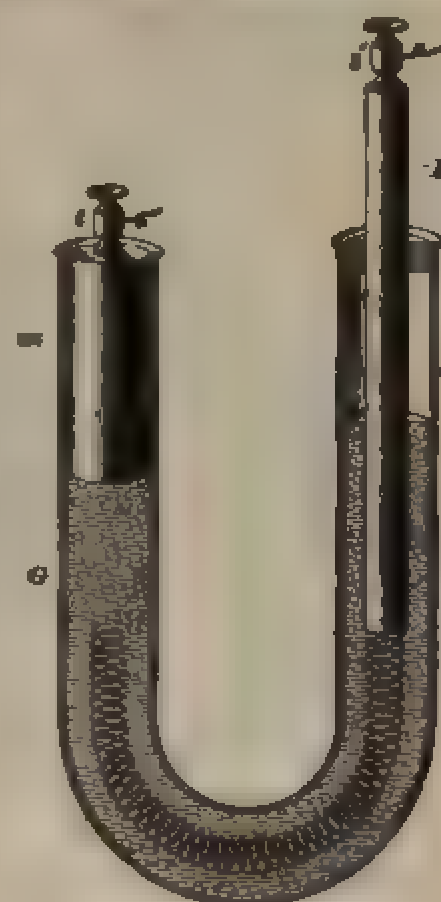

FIG. 9

An Easily Constructed Rheostat

9. Incandescent Current. When the incandescent current is available, such an apparatus as shown in Fig. 11 will be found most convenient and reliable for office-practice. *A* is a motor-generator, of which there are many patterns. Fig. 12 shows another design. These are useful for operating drills, saws, etc. It generates an alternating current. *B* is a double induction-coil wound for a light at one end and for a cautery at the other. These coils have rack-and-pinion adjustment. With the use of such an instrument, which serves as a transformer, the necessity of a rheostat is obviated. *C* is a foot-plate, permitting the operator to make and break connections at will without the aid of an assistant.

FIG. 10

Herdman's Post and Connections

10. Storage-Battery.—The storage-battery, Fig. 13, may be used, always with a rheostat in circuit, and is of considerable advantage because it is portable. The requirements for

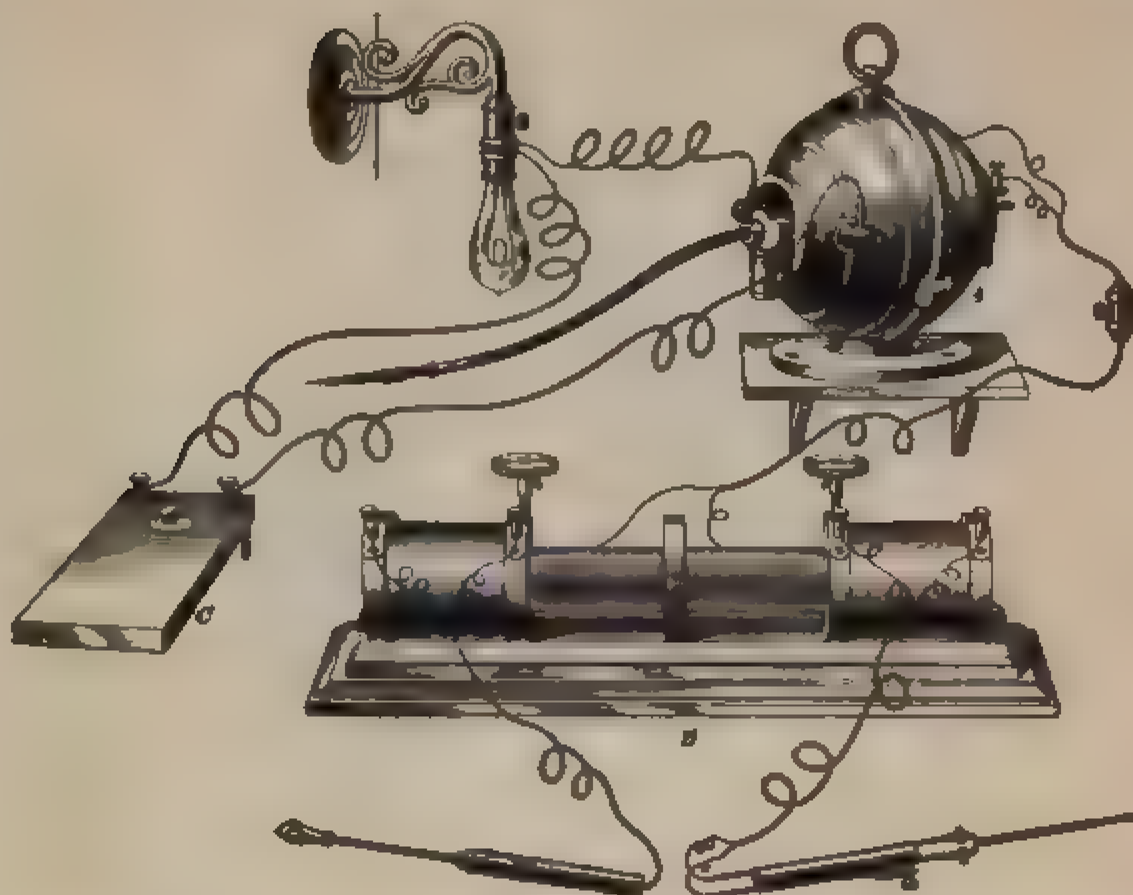

FIG. 11

Illustrating the Adaptation of the Incandescent Circuit for Heating Diagnostic Lamps and Cauteries

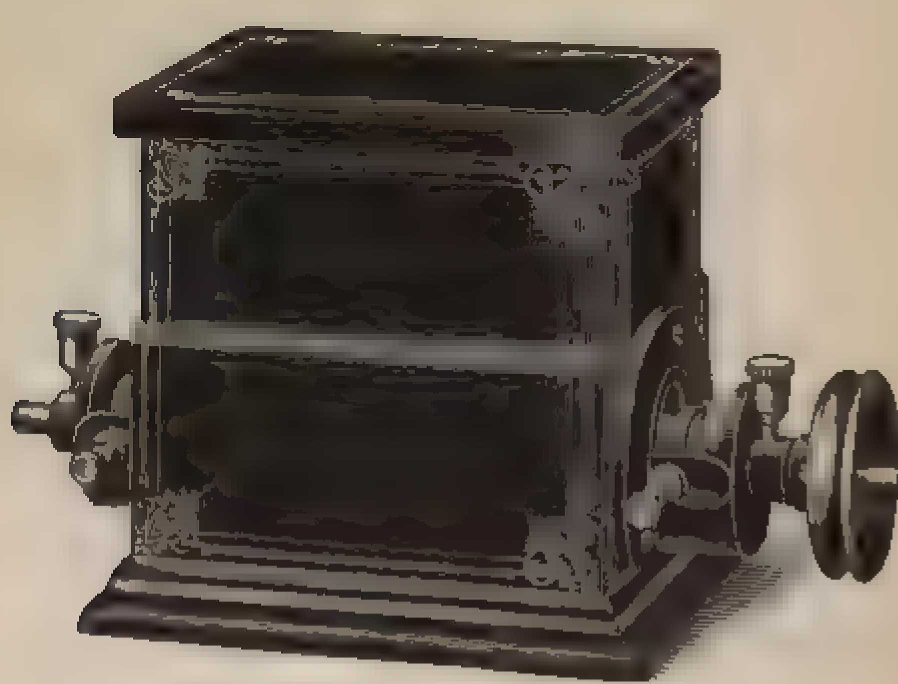

FIG. 12

A Type of Motor Generator

heating a cautery, it should be borne in mind, are altogether different from those for electrolytic or galvanic applications. Electrolysis requires the E. M. F. of many cells or a high voltage to overcome high resistances in the tissues. The same is necessary to heat an incandescent light of 16 candlepower. But to heat a cautery the E. M. F. of two cells is sufficient, provided these cells are of large size. Practitioners who utilize batteries may bring about this requisite by connecting the cells in multiple-arc or *parallel*. This does not increase the E. M. F., but decreases the

Fig. 13
Storage-Battery

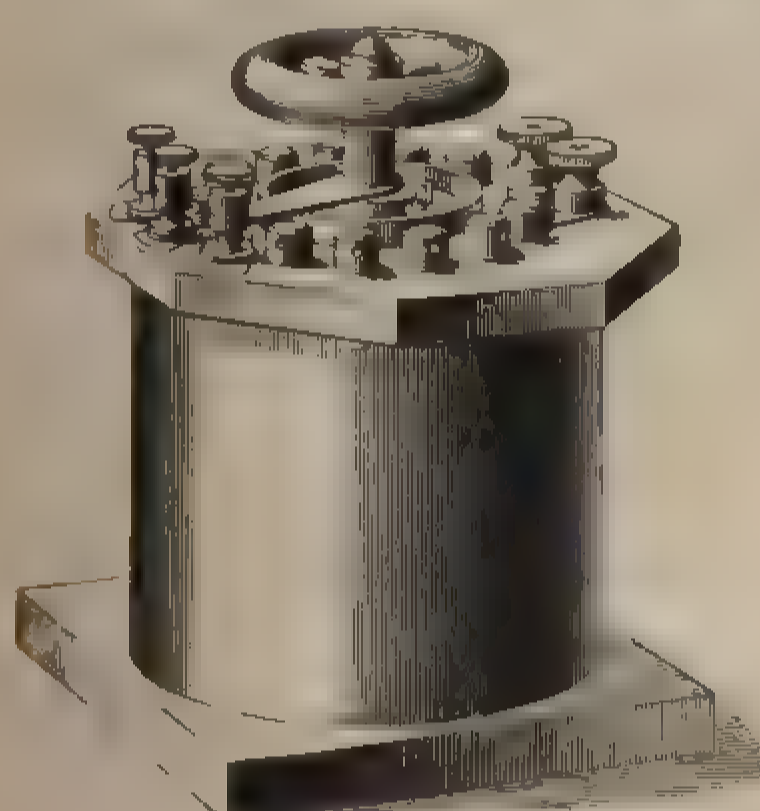

Fig. 14
Transformer

internal resistance. The current from cells in parallel or from the 110-volt circuit will fuse a cautery-knife at once. Some physicians use large bichromate batteries for cautery-work.

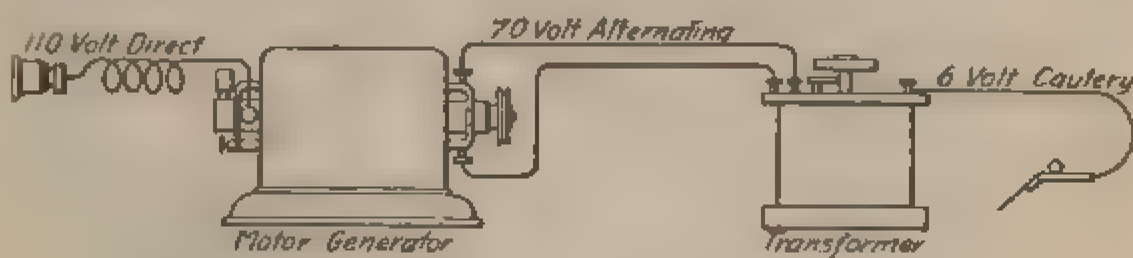

FIG. 15

Showing the Principle on Which Generators and Transformers Operate

They are to be used only where other means are lacking. Accumulators require to be charged frequently from a source giving a constant current of not too high voltage, the E. M. F. of which is greater than that of the accumulator itself. Fig. 14 shows a transformer of good pattern. The principle on which motor-generators and transformers operate is illustrated in Fig. 15.

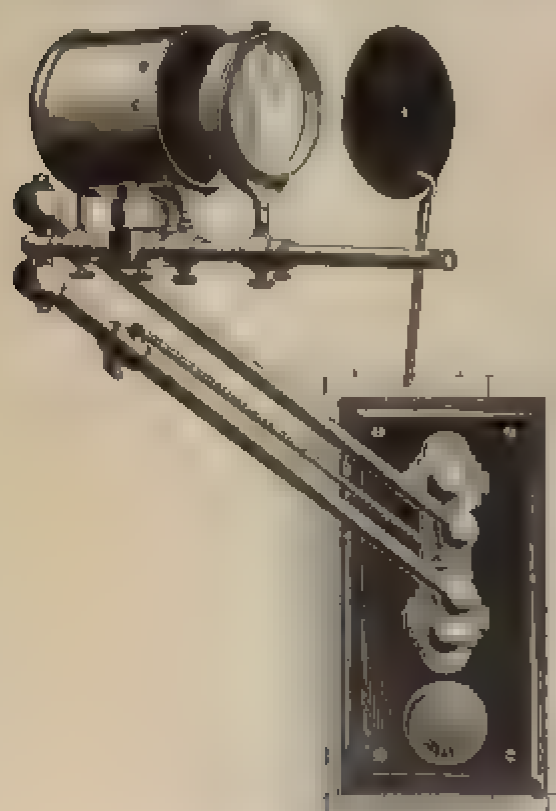

FIG. 16

Illuminator

11. Illumination. For purposes of examination and treatment, the physician is guided in the selection of his artificial light largely by individual preference and taste. The old Argand burner is still largely used. Many use incandescent lamps of 16 to 32 candlepower. Suitably mounted, these are ordinarily adapted for the specialist's use. Fig. 16 shows a good arrangement. We have found the ordinary acetylene bicycle lamp very serviceable. It yields

FIG. 17
Pharyngeal Electrodiagnostic Lamp

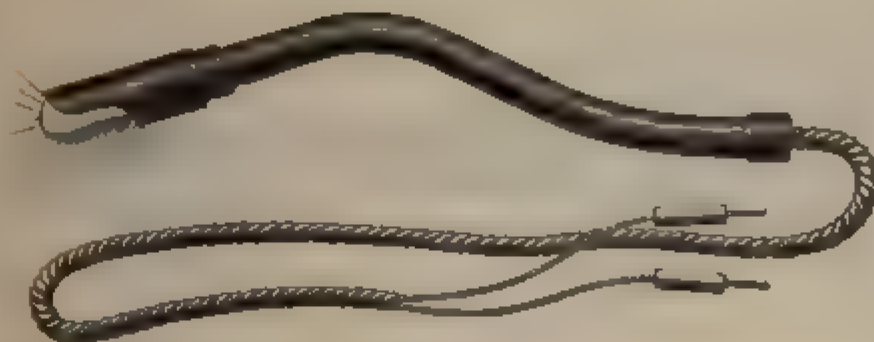

FIG. 18

FIG. 19

FIG. 20
Nasopharyngeal Lamps

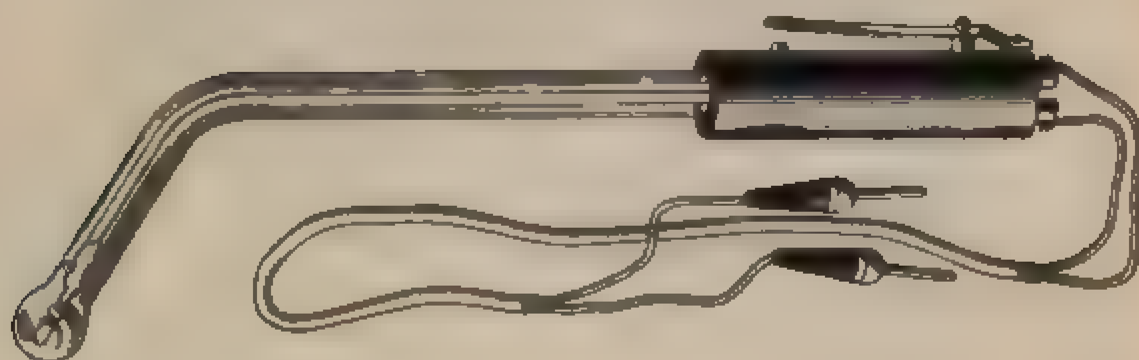

FIG. 21
Laryngeal Illuminator

FIG. 22
Single-Cell Electromagnet

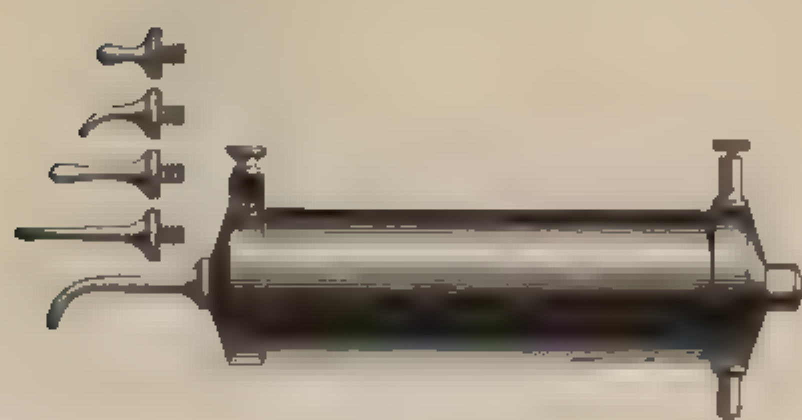

FIG. 23
Hirschberg's Magnet

a steady, strong, white light. The slight odor and trifling annoyance of recharging the lamp are its only faults. Figs. 17 to 21 show some of the electrodiagnostic lamps for use about the nose, throat, and larynx.

12. Electromagnets.—In the removal of metallic foreign bodies from the eye the electromagnet will be of service. A magnet of small size that can be operated by one cell is shown in Fig. 22. It is useful only in removing small particles of metal lying loose in the conjunctival sac. A portable, yet quite strong, magnet is that shown in Fig. 23. It has several adjustable tips to meet different emergencies. Haab's magnet, shown in Fig. 24, is the most powerful electromagnet of all. It is intended for the removal of particles of iron or steel embedded in the tissues of the eye and for the most part inaccessible. Further mention of these magnets will be made later.

FIG. 24

Haab's Magnet

13. Apparatus for the Generation of X-, or Roentgen, Rays. For a description of the various sources of the cathode rays the student is referred to *The Physics of Roentgen Rays*. The larger modification of the Ruhmkorff coil and the improved modern static machine are the sources most frequently and advantageously employed.

DISEASES OF THE EYE

14. In the treatment of the various affections of the eye and contiguous parts, it must be borne in mind that a rational system of therapeutics is based on a correct understanding of pathology. Some conditions may be due to remote and constitutional disturbance rather than to causes purely local. In every case, therefore, the practitioner will aim to remove or ameliorate the primary factor in the disease, whether that be local or general, and will use every agent consistent with the teachings of experience, both to bring this about and to restore the parts to their normal condition. The applications of electricity frequently need to be supplemented with further local treatment, or electricity may simply serve as an adjuvant to some other plan of procedure.

DISEASES OF THE LIDS

TRICHIASIS AND DISTICHIASIS

15. Trichiasis and distichiasis may arise from a variety of causes, the principal one of which appears to be a proliferation about the epithelial structures of the hair-follicles. A constant hyperemia or inflammatory condition of mild degree about the margins of the lids may bring this about. The cilia frequently take an erratic direction and grow inwardly upon the eyeball, causing, by the irritation they produce, considerable pain and spasm of the lids. So great may the irritation become that it will lead to ulceration and opacities of the cornea. A similar condition is frequently seen in entropion.

16. Treatment.—The treatment consists in removing the surplus and erratic hairs. Ordinary epilation will not suffice, since it does not prevent a return of the trouble. Electrolysis offers the best results in all cases where the cilia are not too thickly grouped or too abundant. Following the proper application of this method the hairs do not return.

17. Place in circuit a rheostat and a milliammeter, and so govern the current that the needle of the meter stands at zero. Attach to the cathode, or negative terminal wire, a fine steel, or best, an iridoplatinum needle, inserted into a needle-holder of convenient type (see Fig. 25). To the anode, or positive pole, or terminal, attach an electrode well wrapped with absorbent cotton, which is to be moistened with salt-solution.

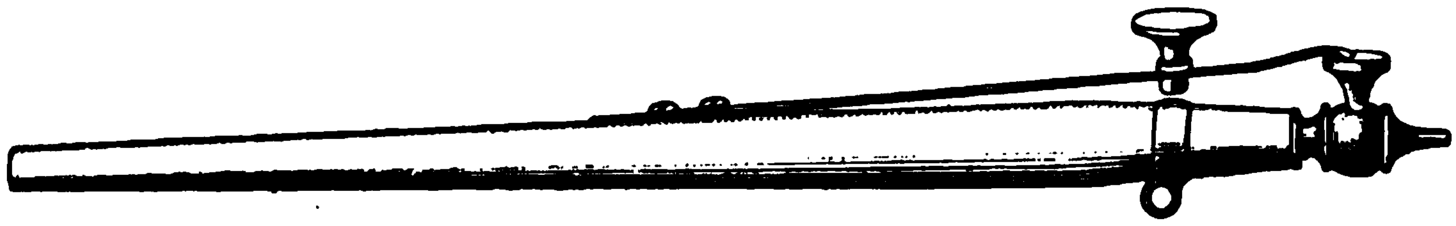

Fig. 25
Needle-Holder

Should there be any doubt as to which pole is the cathode and which the anode, place both terminals in a dish of water. Hydrogen bubbles will collect at the cathode if the current is operating. Place the patient in a good light before you, adjust the anode either to the patient's hand or apply it to the neck or cheek. The electrode shown in Fig. 26 may be applied to the malar prominence, and will be found serviceable in other applications of electricity about the eye. With the eyelid slightly everted and steadied by the hand of an assistant, grasp the hair to be removed with cilia-forceps and pass the needle alongside the hair at its base, into the follicle, and beyond. The circuit should now be closed and the rheostat operated, so as to allow a gradual increase of current from 0 to 4 milliamperes. In from 10 to 50 seconds the tissues about the point of entrance of the needle will begin to look white, and tiny bubbles of gas appear. Slight traction on the hair will remove it. Withdraw the needle. The electrolytic action of the current has caused a slough about the site of the follicle and destroyed it.

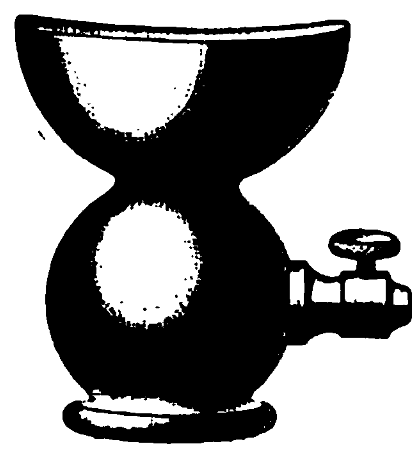

Fig. 26
Electrode

18. The operation, though not severe, causes some pain. From three to ten hairs may be removed at a sitting, according

to the fortitude of the patient. There is usually profuse lacrimation and slight hyperemia may result for a few hours. Sittings may be held as often as every other day. It is advisable to allow an interval of 24 hours or more to elapse between these applications, in order to permit all irritation to subside. In cases where the cilia are in such abundance as to make their removal by electrolysis impracticable, some one of the methods of excision or transplantation will be found more serviceable. It must not be forgotten that the cicatrix resulting from multiple applications of the electrolytic needle within a small space is by no means slight.

HERPES ZOSTER

19. Nature.—**Herpes zoster,** which is a painful and sometimes dangerous affection, is due to derangement of some of the branches of the supraorbital or infraorbital division of the fifth nerve. The disease is self-limited and seldom calls for active therapeutic measures, save when the herpetic vesicles appear on the cornea, in which case ulcers and opacities are the rule. The condition is ushered in by slight, if any, constitutional disturbance, but the pain is burning and intense. After a few days, pain diminishes and the vesicles appear either in a discrete or confluent form—usually the former.

20. Treatment.—The treatment consists in soothing applications, the hypodermic use of morphin when necessary, and close attention to complications if they arise. The application of a constant electric current to the diseased parts and to the closed lids, of intensity just sufficient to cause a feeling of warmth, will be found serviceable in mitigating the pain and lessening the severity of the attack. Either pole may be made the active one, and it is well to change the polarity frequently during the sitting.

RODENT ULCER

21. Nature.—This variety of epithelioma is usually a companion of advanced years, and runs a characteristically slow but certain course. In its early stages, when it appears as a small shallow ulcer covered with a scab, situated usually at the

inner canthus of the eye, it is particularly suited for electrical treatment. In some cases electrolysis accomplishes a speedy cure without the necessity for more vigorous intervention. It must be understood that the treatment, of whatever character it may consist, must be directed well beyond the diseased focus into healthy tissues in order to destroy the morbid process and prevent a recurrence.

22. Treatment.—The ordinary method of treatment consists in the thorough removal of all diseased tissue with the knife and the application of the thermocautery or some chemical caustic to the base. The application of saturated solutions of chlorate of potash to the parts, together with the administration of the drug in full doses, has met with some success. Electrolysis should always be tried in cases where the ulcer is accessible, small in size, and in its earlier stages. The mode of application is as follows: Select a new, sharp needle of iridoplatinum and attach it to a holder carrying the anode terminal wire. The cathode, or indifferent pole, is to be attached to a convenient electrode, which may be applied to the patient's cheek. Introduce the needle into the *healthy tissues* beneath the base of the ulcer at one margin parallel to the plane of its surface. With the milliammeter at zero, gradually increase the current until 5 to 8 milliamperes is passing, and maintain this intensity for 2 or 3 minutes. The current should now be shut off and the needle withdrawn and introduced at a point nearer the center of the margin of the ulcer. In this manner the entire base of the ulcer and the healthy tissues beyond are subjected to electrolytic action. The anode causes a coagulation of the tissues and the blood-vessels supplying the part. A necrosis of the peripheral tissues occurs and the slough separates, leaving healthy granulation tissue, which soon cicatrizes. Should the operator experience any difficulty in withdrawing the needle after passing the current, he may overcome it by simply reversing the polarity for an instant. It is never wise to tear the needle rudely from the tissues. This treatment may be given in one sitting or in divided sittings. In the former case it is well to anesthetize the patient.

23. Another means of applying electrolysis is what is termed the *bipolar method*, in distinction to that just outlined, which is sometimes spoken of as the *unipolar*, or *monopolar*, *method*. In the bipolar method we make use of an electrode specially devised (see Fig. 27). The needle-holder is so arranged as to bring the anode and cathode into close proximity without actual contact. Many operators claim better results by the use of the bipolar method. The results are

FIG. 27
Needle-Carrier for Bipolar Electrolysis

the same in either case. The needles are introduced in the manner described above and the application of the current is the same. The parts should be protected after the operation and kept thoroughly aseptic. Should recurrence take place more radical operative steps will be necessary and should not be deferred.

TUMORS OF THE LIDS

24. Chalazion.—These little cysts vary in size considerably and seldom give the patient much annoyance unless they become large enough to interfere with the functions of the lid or open spontaneously into the conjunctival sac. More than one may be present at a time. It is impossible to cause these tumors to disappear by any means other than operative.

25. Treatment.—Incision into the cyst through the conjunctiva and thorough curettage of its walls is the ordinary method of dealing with the condition. Electrolysis is very serviceable and should be afforded a trial before the more extensive plan outlined above is attempted. An iridoplatinum needle is made the cathode and introduced into the tumor on its conjunctival surface. It may be introduced on the exterior, in which case the needle should be insultated to the point where it touches the skin, so as to avoid possible sloughing. The

indifferent electrode may be applied to the brow or the neck. A current of 2 milliamperes should be passed through the tissues for a period of 2 or 3 minutes. The séance may be repeated in 24 hours. One or two applications will suffice for cysts of ordinary size.

26. In cases where the lids are greatly thickened from an old chalazion or from a series of sties, the application of the constant current may be useful. Grasp the tissues of the lid by a specially devised electrode or by an ordinary pair of tissue-forceps, which is made the cathode terminal. The anode may be placed at any site. A gentle current of from 1 to 2 milliamperes is to be applied at regular intervals for 4 or 5 minutes at each sitting. The tough and brawny condition frequently clears up materially after a few applications.

27. Cancer, Sarcoma, and Fibroma.—These tumors of malignant and non-malignant type need no special or detailed description. The pure fibromata are the only growths which are not malignant in character and which may permit of delay in removal. All malignant tumors should be attacked early and radically. It is to be recalled that these disseminate rapidly through the lymphatics and blood-vessels.

28. Bipolar electrolysis applied thoroughly to the bases of the tumors in this situation offers a certain means of removal. It will accomplish nothing beyond the original focus and will not prevent the growth of metastases which have already occurred. The method of application consists in passing the needle into the bases of the tumors well beneath the diseased tissue and administering a current of from 1 to 10 milliamperes for 2 to 5 minutes, according to the conditions present. It is essential to electrolyze the tissues around and beyond the entire base of the disease. If, for any reason, it is considered necessary to use a higher amperage, an anesthetic will have to be used.

29. Vascular Nævi.—These disfiguring blemishes of the eyelids offer the most favorable field for electrolytic work about

the eye. The treatment is the same as in nævi elsewhere about the face or body. Some operators prefer to use the cathode, others the anode, as the active pole. Certain it is that in nævi of a telangiectatic type the anode is always to be preferred. The sittings may be held as often as every other day. The current should vary between 1 and 2 milliamperes, and the length of its application 1 or 2 minutes. Always attack the nævus at its periphery except where the wart is very small. The needles should be of iridoplatinum or platinum.

LUPUS

30. Electrolysis may be employed in the treatment of the stubborn condition known as **lupus**. Good results are frequently brought about. The more brilliant results attained by the use of Finsen phototherapy should encourage operators to avail themselves of the method where possible.

FIBRILLARY TWITCHING OF LIDS

31. This rather annoying condition may be benefited by the stabile or labile application of a gentle constant current. Moistened electrodes are used. The anode is to be placed on the closed lids or gently rubbed over them, or the moistened fingers of the operator may be made the anode, and the lid gently stroked.

ENTROPION AND ECTROPION

32. The pathology of these affections is so well understood that there will be no necessity to dwell thereon. In general, there are but two forms common to each, the cicatricial and the muscular. We shall deal with the former alone. The cicatrix may be so extensive as to involve the tarsus, a point which should be borne in mind. The complications and sequelæ attendant upon entropion are largely those following distichiasis, and the operations mentioned under that head are applicable to mild cases. Unless a great number of hairs impinge on the cornea their removal by electrolysis will be of great benefit and relief to the patient.

33. Treatment.—For the various operations employed in the relief of these conditions, the student is referred to text-books on the eye. Electrolysis has met with slight favor. In entropion of a mild nature due to contracture, which does not involve the tarsus, we may make use of the electrolytic needle to considerable advantage. The principle is based on the sloughing action of the cathode and is used to break up the bands of scar-tissue in the eyelid. A steel or platinum needle slightly curved and mounted in a holder is made the cathode and is passed into the eyelid in the following manner: Introduce the needle at a point near the outer canthus of the eye about $\frac{1}{4}$ inch from the margin of the lid; carry it beneath the skin along the palpebral border to near the inner canthus, taking care to avoid the hair-follicles. The indifferent electrode is applied to the temple or cheek. A current of 5 milliamperes is passed for 5 minutes. It will be found on withdrawing the needle that the lid tends to assume more nearly its normal position, owing to the solution of the constricting bands. If one sitting is insufficient, a second may be held, passing the needle this time still farther back from the palpebral border. Unfortunately, the results of this operation are not always permanent.

34. The electrocautery may be used effectively in the treatment of both entropion and ectropion. Its application is based on a rational hypothesis, and consists in creating scar-tissue in the lid on the surface opposite to the direction of distortion, which, by its contraction, tends to restore the normal position of the structures. The method of application is as follows: Select a cautery-tip with a narrow, but not sharp, platinum blade and fit it to a convenient handle (see Figs. 28 and 29). By means of a transformer or rheostat so control

FIG. 28

Cautery-Tip and Handle

FIG. 29

Cautery-Tip and Handle Bearing Make-and-Break Key

the current as to bring the cautery-tip to a white heat. The patient should be anesthetized. If the lid is in a condition of entropion, steady it by means of Knapp's clamp and incise through the skin along the margin from the external canthus to the punctum lacrimal well down to the tarsal cartilage The incision should avoid injuring the hair-follicles. The operation in ectropion is similar with the exception that the affected lid is everted and the incision carried along its conjunctival surface. A second incision parallel to the first and farther from the palpebral border may be required (see Fig. 30). The after-treatment requires cooling compresses and bandages to the eye. Ectropion and entropion due to atony and atrophy of individual fibers of the orbicularis palpebrarum may be benefited by faradization of the atrophied bundles with fine electrodes. Patiently continued for a long period this treatment will restore the position of the lid.

FIG 30
The Electrocautery Incision in Entropion

DISEASES OF THE LACRIMAL APPARATUS

STENOSIS OF THE LACRIMAL CANAL

35. In stenosis of the lacrimal canal the stricture may occur at any point along the passage, either at the punctum, in the canaliculus, or in the nasal duct. In the first-named position the condition generally arises from blepharitis, or conjunctivitis, in the second from an extension of inflammatory processes or the presence of a minute foreign body,

while a narrowing of the nasal canal depends as a rule on the presence of long-continued nasal catarrh. The symptom common to all derangements of the lacrimal passage is the leaky eye.

36. In electrolysis we possess the most valuable of all therapeutic agents in the treatment of this disorder. The results of its application show a greater number of cures and a lesser number of relapses than with other methods. The operator may avail himself of the ordinary Bowman probes or he may obtain a set of graduated platinum sounds. The latter are better for the purpose. These sounds should be insulated to various distances from the tip with shellac or other substance, so that when in position the punctum and conjunctiva will not be subjected to electrolysis. This precaution is important since occlusion of the punctum has followed its neglect. The probe is to be passed into the passage in the usual manner until the constriction is reached and the tip of the instrument has gone slightly beyond. To the probe is attached the cathode-terminal. The anode may consist of a piece of copper wire or an ordinary probe wrapped with moist, absorbent cotton. This indifferent electrode should be introduced into the nasal chamber of the same side. With the needle of the milliammeter at zero, gradually increase the current until 5 milliamperes are passing. Continue the strength of current at this point for a moment and then gradually diminish until no current is discernible. This operation should consume from 3 to 4 minutes. Generally a little white froth will collect about the punctum. The probe will be found to lie much more loosely in the canal and may be withdrawn without difficulty, whereas it was firmly grasped by the tissues at its introduction. Each day for a week following the operation the probe should be passed, to prevent a subsequent narrowing of the canal. If a probe of larger size can be accommodated, so much the better. At the end of a week the operation may be repeated with a larger probe. There is very little pain or discomfort to be felt during the treatment, and the relief to the patient is most gratifying.

DISEASES OF THE CONJUNCTIVA

TRACHOMA, OR GRANULAR OPHTHALMIA

37. There is little to be said in regard to the acute form of this disease, since electricity is seldom if ever used for its relief. Other therapeutic agents yield better results. With the chronic form of trachoma, however, we shall deal to some extent and endeavor to establish for it a method of treatment well-nigh infallible. The pathological condition that confronts us has a varied picture, depending somewhat on the stage of activity of the morbid process. The disease acquires its name from the presence on the conjunctiva of small grayish granules, which are confined to the fornix and palpebral layers. Histologically, these granules are made up of lymphoid and fibrous tissue, and they are formed in the stroma proper of the conjunctiva. They are nothing else than small, new growths, which have a tendency to grow together into islands and, by the contraction of their fibrous elements, to obliterate the mucous surface of the lid and render it one mass of scar-tissue. The subsequent contraction of this scar-tissue is a cause of entropion, the treatment of which we have previously considered. A condition called pannus, or a vascularization of the cornea, is a frequent complication of the affection. We shall refer to it again later. Corneal ulcers are occasionally complications at some stage of the disease.

38. Treatment.—The inevitable tendency toward the production of scar-tissue, which characterizes the granular ophthalmia, should sound a note of warning in regard to treatment. Any method that requires the use of scarification or the application of caustics, or escharotics, should be condemned for the simple reason that it will increase the cicatrization. The aim must be to destroy the individual granulations or the fused masses which they form without injury to the areas of conjunctiva around and between them. By this means alone will a satisfactory outcome be obtained. The treatment by expression is one ordinarily in use and is very serviceable. Knapp's

cylinder forceps are employed for the purpose. Electricity has been used in a variety of ways. One method consisted in applying cupric cathodal electrolysis to the everted lids. It was based on an incorrect understanding of the action of the current. Another plan was to employ cupric cataphoresis or anodal diffusion, while still another form of electric application consisted in cathodal electrolysis, with steel needles, of the furrows produced by preliminary scarification. All these therapeutic hints have been supplanted by the more rational plan of dealing with these granules as new growths and electrolyzing their bases. The anode is made the active pole and to it is attached a fine needle of iridoplatinum. The moistened cathode plate may be adjusted to the neck. With the lid well everted and held steady, the needle is passed beneath the base of one of the granular masses. A current of 1½ to 2 milliamperes should be allowed to pass for 1 or 2 minutes, or until a whitish, cheesy mass is seen to form about the point of entrance of the needle. The nutrient vessels are coagulated and the granule undergoes coagulation necrosis and is quickly absorbed. If the granule is of large size, the needle should be passed in several directions beneath its base. Eight or ten of these masses may be treated at a single sitting. The reaction is slight and transitory and the hyperemia resulting is beneficial rather than otherwise. It is needless to say that the field of operation should be thoroughly anesthetized with a 4-per-cent. solution of cocain. An interval of 2 or more days should interrupt the treatment. A 3-per-cent. infusion of jequirity has been found useful where there is but slight blennorrhea, and particularly where pannus is present. The inflammation resulting from its use will frequently subside, leaving a clear cornea, but, unfortunately, the granular condition is not always correspondingly benefited. Its use is not unattended with danger.

39. Pannus.—The electrocautery is serviceable as an adjuvant to the operation of peritomy for the relief of obstinate *pannus*. The incision is made through the vascularized tissue and conjunctiva in the usual manner around the cornea about ¼ inch from its outer margin. The incision severs all tissue

down to the sclera. With the blunt extremity or flat surface of a platinum cautery-tip at white heat the inner fringe and circle of vascularized tissue is singed down to the anterior elastic layer of the cornea. This procedure is more radical and meets with better results than dissecting up the tissues to the corneal

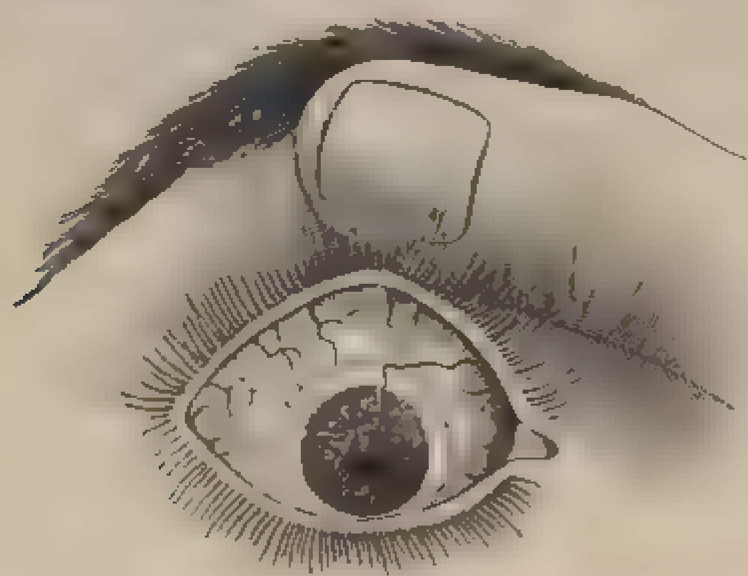

FIG. 31

Pannus, Showing Line of Proposed Cauterization

rim and there cutting them free (see Fig. 31). Cases have been reported where benefit was obtained by galvanization of the cervical sympathetic, the anode serving as the active pole.

PHLYCTENULAR CONJUNCTIVITIS

40. Where there is a solitary phlyctenula, puncture of the vesicle with a fine cautery-tip at a white heat will prove very satisfactory. The floor of the vesicle should receive a light touch of the heated cautery. A small bit of yellow oxid-of-mercury ointment, or still better, a bit of calomel powder, may be placed upon the eschar and ice applications employed. Phlyctenula of the cornea will receive attention later. The cautery is not available in cases where the phlyctenulæ are numerous or miliary in character. For the relief of pain, photophobia, and blepharospasm, in addition to the ordinary applications of cold and atropin, mild faradization is extremely

serviceable. Place an induction-coil in circuit and control the current so that only the slightest sensation is conveyed Attach one electrode to a moistened sponge-plate and place it on the patient's neck at the back. The other electrode may be wrapped in moist cotton and laid gently upon the closed lids, or the special sponge-electrode, Fig. 32, may be used. The current may now be gradually increased to a point agreeable to the patient. The applications may be made a frequent intervals during the day, but should not continue longer than 5 minutes at a time.

FIG. 32

Binocular Sponge-Electrode

PTERYGIUM

41. In the treatment of **pterygium,** electrolysis finds its proper sphere and bids fair to supplant entirely the ordinary operations of ligation and excision. A fine iridoplatinum needle is made the anode and is passed well into the neck of the growth, or at a point a trifle nearer the base, in a direction opposite or at a right angle to the direction of growth—crosswise. The cathode is applied to the back of the neck or upon the mastoid of the same side. A current of 1 to 1½ milliamperes is allowed to pass for ½ to 1 minute. The needle is to be withdrawn with great care, so as to avoid pulling or tearing the parts. Should the needle be firmly in the grasp of the tissues, reverse the polarity for an instant before attempting to withdraw it. Usually one sitting is sufficient. The eye should be thoroughly cocainized before all operations thereon. If we bear in mind the fact that in general the anode is the coagulating pole and the cathode the sloughing pole, we shall have little difficulty in effecting the desired electrolytic results. *Be certain of polarity always before applying galvanic currents.*

TUBERCULOSIS

42. The importance of an early diagnosis in **tuberculosis** cannot be too strongly urged. Essentially a chronic disease, the course may cover a period of several years before the eye becomes generally affected, but the danger lies not so much in the loss of the eye as in allowing a primary focus of tuberculosis to exist. General tuberculosis is a frequent sequel. The disease begins in the palpebral conjunctiva, generally in young individuals, as small grayish-yellow granulations that soon break down and form ulcers with clearly outlined margins and covered with reddish-gray granulation-tissue. The tissues of the lid become greatly swollen and the ulcerative process frequently extends to the lids themselves. Lupus reaches the conjunctiva by process of extension from the skin, and may be differentiated by the peculiarity of healing in one spot and progression in another, which is characteristic. The ulcers are a deeper red and bleed easily.

43. Treatment.—Either condition calls for prompt and thorough application of the electrocautery. With the eye thoroughly cocainized, bring the tip of the cautery to a white heat and sear each granulation and ulcer, taking pains to go deep enough into the tissues to destroy the morbid process entirely. Where possible, all diseased foci should be attended to at a single sitting, so as to avoid reinfection. Ordinary antiphlogistic measures should follow. Where the disease is so far advanced as to involve the iris or cornea, immediate enucleation of the eye offers the only recourse consistent with safety to the patient.

44. Malignant tumors, particularly in their earlier stages, call for prompt electrolytic treatment or removal with the knife followed by thorough applications of the electrocautery.

DISEASES OF THE CORNEA

45. Were we compelled to spend our days in habitations where the windows were of ground glass, we could the more easily appreciate the fate of the unfortunate individuals who have sustained corneal disease. Nearly all affections of the

window of the eye leave opacities of greater or less density and some lead to a more serious sequel—the complete loss of vision. It is readily understood, therefore, how important is a correct knowledge of the various morbid processes affecting the cornea and how untiring the specialist should be in the effort to combat the progress of disease and in the search for measures to alleviate the unfortunate sequelæ. We can afford to leave no therapeutic path unexplored. The opinion is ventured that the testimony of many persons who bear the *white eyes* will establish the fact that nothing was ever done for their trouble after the subsidence of the disease in its active stages. Many an opacity and stain have been removed, however, by the patient effort of a consistent worker who does not hesitate to employ remedies little known and to explore new regions in the effort to improve his resources.

KERATITIS

46. It will be unnecessary for us to review the pathology of the various forms of **keratitis.** The germ-theory of disease has thrown much new light on the subject, and demonstrated, in many cases, a system of treatment more rational than that in vogue a decade or two ago. An injury coupled with a microbic factor will lead to active inflammation. Suppuration is looked on as a complication rather than an essential to the healing of tissues.

Prominent symptoms in all forms of keratitis are *pain* and *blepharospasm.* In addition to the ordinary means for their relief the application of faradization will be found very useful. In fact, in all painful affections about the eyes, particularly of inflammatory character, the induced current should be given through the closed lids, using either sponge-electrodes or gently stroking the parts with the hand in circuit. The strength of current should be slight and the applications frequent. Some authors report cases relieved by the use of a galvanic current of 1½ to 2 milliamperes continued for 5 minutes. The cathode is applied to the lids or supraorbital notch, and the anode to the cheek. The method is worthy of a trial if others fail.

47. Epithelial and **parenchymatous keratitis may** be benefited by the judicious application of the constant current. It has been argued by some that the instances where electricity has proved successful are few and that the successful cases were probably in adults at which age the prognosis is generally favorable under any form of treatment. This may be met by stating that such complications as iritis, cyclitis, and vitreous opacities are observed in adults and that many of the successful cases occurred in children. Atropin and fomentations should never be omitted. In addition to faradization for the relief of photophobia and pain we should make direct applications of the galvanic current. The anode is placed upon the brow or cheek, and the cathode is attached to a small bit of fine sponge or a delicate sponge-tipped electrode of special pattern. The cornea should be gently brushed with the sponge, taking care not to break contact. The current should not exceed 1½ milliamperes. A duration of 2 minutes is amply sufficient. Alternating with this treatment a constant current of greater intensity, say 2 to 4 milliamperes, may be given to the affected eye through the closed lid for 3 to 5 minutes. It is advisable to discontinue electrical treatment now and then and substitute applications of yellow-precipitate ointment. Sometimes general mercurial inunctions are serviceable. As the cornea begins to clear up, the intervals between electrical sittings may be lengthened.

48. Neuroparalytic keratitis, so called, may be relieved in some instances by the stabile and labile applications of a constant current of 2 to 5 milliamperes for short periods. The cathode-sponge should be the active electrode, and is applied to the closed lids. The anode is placed in any convenient site, as for instance the brow, cheek, or patient's hand. The proper moistening of the electrodes should never be neglected. It is perhaps wise to caution the operator to be on the watch for vesication at the site of the anode.

49. Phlyctenular keratitis is a concomitant of the corresponding disease of the conjunctiva, and calls for the therapeutic measures outlined in the section devoted to that subject. Atropin, yellow oxid-of-mercury ointment, calomel powder,

and fomentations constitute the ordinary treatment. It is in the ulcers resulting from the broken-down vesicles that treatment by electrocautery finds its limits of perfection. The method of application will be referred to later, when treating on ulcers of the cornea. Not merely is this agent recommended in superficial troubles, but also for purposes of paracentesis, together with use of eserin to guard against possible hernia of the iris. When one large phlyctenula or perhaps two or three smaller ones appear upon the cornea, the timely use of the electrocautery may prevent undesirable results. The vesicle or vesicles should be touched with the small, blunt cautery-tip brought to a white heat, pains being taken not merely to rupture the little sac but to bring the tip in contact with the base and margins. The indications are the same if the vesicles have already ruptured spontaneously. In obstinate cases where other means have failed, the cautery will solve the difficulty. Recurrent forms call for repeated applications.

ULCERS OF THE CORNEA

50. Infiltration, ulceration, and cicatrization are the stages through which most affections of the cornea must pass. Each stage may be more or less severe, depending on the nature of the process or on the exciting cause. It is not so much our province to inquire into the causes of these conditions as it is to promote healing and subsequently to remove any deposits, so far as we may. The ulcer may be superficial or deep, dry or purulent, serpiginous or rodent, marginal or central. These different types represent various characteristics of form, size, and rate of progress. Some are infective, others not, depending on the variety of cause, microbic or otherwise.

51. Treatment.—In general terms the treatment of all forms of ulcer is the same. The utmost vigilance is necessary, since some of the worst forms to deal with present the fewest symptoms and many are very rapid in their course. For pain, spasm, and lacrimation the faradic current, as before outlined, is commended. The instillation of atropin should not be neglected. A properly adjusted compress-bandage is valuable

repair. There is usually some opacity of the cicatrix thou may be very slight in favorable cases. Electricity unfo nately has no place in the treatment of the synechia prolapses that occasionally occur in neglected instances sometimes complicate the operable cases. Some of the c writers treated corneal ulcer by faradism, stroking the with a hair-brush, which was made the cathode. The me has given way to a better one. The hypopyon so freque associated with ulcer usually disappears spontaneously. Sh it persist, its absorption may be hastened by applyin current of 1 to 2 milliamperes to the closed lids thr the cathode-sponge once or twice daily for 5 or 7 minu

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OPACITIES OF THE CORNEA

53. The treatment of opacity of the cornea, also c nebula or leucoma, is based on the hypothesis that stimulation of scar-tissue will promote absorption and favo deposit of a tissue more normal in character. In the ca corneal structure this tissue is clear. Much time and e have been spent in determining just what amount of stimul is required to bring about the desired end without produ a reaction inflammatory in character. The character of stimulus is also of importance. In galvanism we posses available agent for the treatment of opacities. It is stimul and is capable of very fine gradations in strength. R opacities, it must be borne in mind, respond much rapidly to stimuli than old ones, so that in treating fresh we apply only the gentlest currents. The cathode is the a pole. The electrode may consist of a silver probe, or soun a bulb-tipped bougie. It should be rubbed very gently the cocainized cornea near the scar-tissue while a curre $\frac{1}{2}$ to 1 milliampere is passing. Use always a low ampe but gradually increase the time of the sitting. The eye become injected and the conjunctiva flushed while the cu is flowing, but this irritation is transitory and subsides wit few hours. The eye should be kept closed for half a day treatment. The patient should receive attention as oft

every second day. The best results are looked for in opacities following interstitial keratitis, but scars from old ulcers clear up remarkably under the treatment. The margin of the nebula is the first to clear.

KERATOCONUS AND ANTERIOR STAPHYLOMA

54. These conditions, resulting usually from perforating ulcers, demand operative interference as a rule, particularly where associated with synechia and leucoma. The outlook for sight is poor indeed and frequently the patient gains an improved cosmetic appearance and little more. In simple keratoconus due to atrophy, fair results are obtained by creating an ulcer near the summit of the cone with the electrocautery lightly applied. The ulcer is placed to one side of the pupilary space, if possible, so that the resulting cicatrix will not blur the vision. Should a nebula result, it may be dispersed by galvanic stimulation, as previously mentioned. The results are usually good. The electrocautery is used in anterior staphyloma with leucoma, and is best applied with a narrow-bladed cautery-tip, as follows: Make a linear burn through the tissues down to the posterior corneal layer. The incision should extend from the upper to the lower margin of the cornea passing to one side of the pupilary opening. The results of this procedure warrant its further trial. Cautery operations possess great advantages in being entirely aseptic.

POWDER GRAINS

55. **Powder grains,** whether embedded in the cornea, conjunctiva, or eyelids, may be removed by the use of the electrocautery. The grains should be attacked soon after the accident, since if allowed to remain long they produce permanent staining. A very fine-pointed tip should be brought to a white heat and passed into the site of each grain, causing a slough large enough to include the particular grain. If the grains be in reasonable numbers, all may be removed by this method at a single operation.

in all forms of ulceration save the secondary types, where there is secretion to be drained. The surgical management of corneal ulcer does not differ materially from that of ulcers elsewhere.

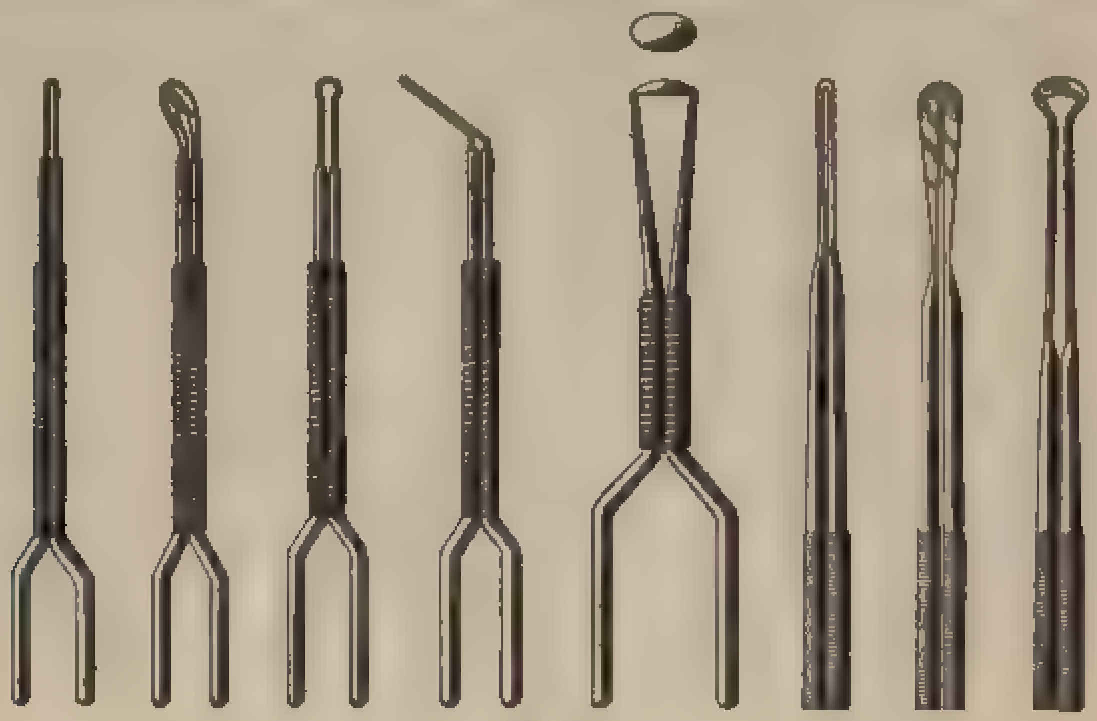

FIG. 33

Cautery Tips for Operations on the Cornea

The indications are to remove all diseased tissue down to a healthy floor and to promote granulation thereon. The curette has been largely used and is valuable. More valuable, still, is the electrocautery. Some of the cautery-tips most commonly employed in operations on the cornea are shown in Fig. 33. A glance at Fig. 34 will show what is necessary to be accomplished. This represents a microscopic section of a cornea through an ulcer; *e* is the surface epithelium, *b* the anterior elastic lamina, *p* the posterior elastic lamina. The floor of the

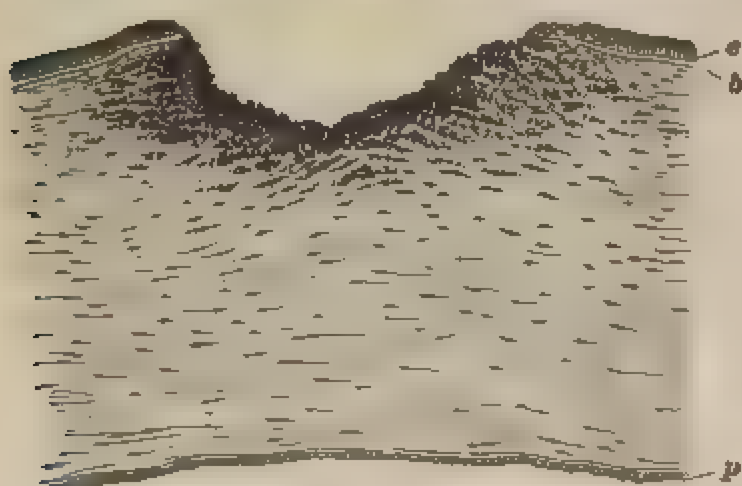

FIG. 34

Vertical Microscopic Section Through a Corneal Ulcer

ulcer is seen crowded with pus-cells and leucocytes. The cautery must clear up this floor and throw off any overhanging edges. See that the electrocautery-apparatus is working well. The operator will be guided in the selection of a tip by the requirements of the case. Regulate the current so that the tip is brought to a white heat instantly, if possible. If there be difficulty in ascertaining just how much tissue must be seared, apply to the eye a solution of fluorescin. This will stain all affected parts. The eye should be thoroughly cocainized. Bring the *unheated* tip carefully and rapidly to the parts, once for practice and then touch again with the cautery-tip brought instantly to a white heat. In simple superficial ulcer no further applications are necessary, as a rule. In suppurating, rodent, or serpiginous forms, we must be watchful for any extension or deepening of the process and check it by another touch of the cautery. Particularly rebellious or indolent ulcers may demand a second séance.

52. Where the ulcer has attained great depth and threatens to perforate the cornea, a different plan of treatment is adopted. Usually in this condition there is great pain, and the thin layer of cornea intervening between the surface and the anterior chamber may be seen to bulge. In these cases paracentesis or perforation of the cornea by the electrocautery is indicated. The curtain of the iris should be well drawn away from the field by atropin. The cautery-tip should consist of a narrow, sharp, platinum blade that will produce a small linear incision through the floor of the ulcer. The method is the same as given above, with the exception that the tip passes entirely through the cornea and permits the escape of the aqueous humor or any hypopyon that may exist. It is better to perform paracentesis without waiting for perforation to become imminent. It is good routine practice in all ulcers of considerable depth. Should we allow an ulcer to perforate, much tissue is lost and the resulting scar is large, whereas if we open the chamber in the manner indicated, there results but a narrow scar and slight opacity. Unfortunately, the surface epithelium and the elastic lamina are not reproduced in the process of

repair. There is usually some opacity of the cicatrix though it may be very slight in favorable cases. Electricity unfortunately has no place in the treatment of the synechia and prolapses that occasionally occur in neglected instances and sometimes complicate the operable cases. Some of the older writers treated corneal ulcer by faradism, stroking the ulcer with a hair-brush, which was made the cathode. The method has given way to a better one. The hypopyon so frequently associated with ulcer usually disappears spontaneously. Should it persist, its absorption may be hastened by applying a current of 1 to 2 milliamperes to the closed lids through the cathode-sponge once or twice daily for 5 or 7 minutes.

OPACITIES OF THE CORNEA

53. The treatment of opacity of the cornea, also called nebula or leucoma, is based on the hypothesis that mild stimulation of scar-tissue will promote absorption and favor the deposit of a tissue more normal in character. In the case of corneal structure this tissue is clear. Much time and effort have been spent in determining just what amount of stimulation is required to bring about the desired end without producing a reaction inflammatory in character. The character of the stimulus is also of importance. In galvanism we possess an available agent for the treatment of opacities. It is stimulating and is capable of very fine gradations in strength. Recent opacities, it must be borne in mind, respond much more rapidly to stimuli than old ones, so that in treating fresh cases we apply only the gentlest currents. The cathode is the active pole. The electrode may consist of a silver probe, or sound, or a bulb-tipped bougie. It should be rubbed very gently over the cocainized cornea near the scar-tissue while a current of ½ to 1 milliampere is passing. Use always a low amperage, but gradually increase the time of the sitting. The eye may become injected and the conjunctiva flushed while the current is flowing, but this irritation is transitory and subsides within a few hours. The eye should be kept closed for half a day after treatment. The patient should receive attention as often as

every second day. The best results are looked for in opacities following interstitial keratitis, but scars from old ulcers clear up remarkably under the treatment. The margin of the nebula is the first to clear.

KERATOCONUS AND ANTERIOR STAPHYLOMA

54. These conditions, resulting usually from perforating ulcers, demand operative interference as a rule, particularly where associated with synechia and leucoma. The outlook for sight is poor indeed and frequently the patient gains an improved cosmetic appearance and little more. In simple keratoconus due to atrophy, fair results are obtained by creating an ulcer near the summit of the cone with the electrocautery lightly applied. The ulcer is placed to one side of the pupilary space, if possible, so that the resulting cicatrix will not blur the vision. Should a nebula result, it may be dispersed by galvanic stimulation, as previously mentioned. The results are usually good. The electrocautery is used in anterior staphyloma with leucoma, and is best applied with a narrow-bladed cautery-tip, as follows: Make a linear burn through the tissues down to the posterior corneal layer. The incision should extend from the upper to the lower margin of the cornea passing to one side of the pupilary opening. The results of this procedure warrant its further trial. Cautery operations possess great advantages in being entirely aseptic.

POWDER GRAINS

55. Powder grains, whether embedded in the cornea, conjunctiva, or eyelids, may be removed by the use of the electrocautery. The grains should be attacked soon after the accident, since if allowed to remain long they produce permanent staining. A very fine-pointed tip should be brought to a white heat and passed into the site of each grain, causing a slough large enough to include the particular grain. If the grains be in reasonable numbers, all may be removed by this method at a single operation.

DISEASES OF THE SCLERA

EPISCLERITIS AND SCLERITIS

56. Superficial and deep inflammations of the sclerotic coat have furnished the theme of animated discussions as regards the availability of electricity in their treatment. Galvanism and electrolysis chiefly have been used. Each method of treatment has found adherents. Operators who have practiced galvanization are not altogether agreed as to which pole should be the active one, some using the anode and others the cathode, applying the electrode directly to the conjunctiva in some cases and indirectly to the eye through the closed lids in others. It is not surprising that out of this confusion there should arise little or no uniformity in results.

57. The practitioners who have used electrolysis are quite in accord as to a scientific plan of treatment. A fine iridoplatinum needle is made the cathode and is introduced into the base of the circumscribed purplish patch or episcleritic button, beneath the conjunctiva. The anode is applied to the back of the neck or to the brow. A current of 2 to 3 milliamperes is permitted to flow for 1 minute. The eye should be completely anesthetized. One electrization is generally sufficient. We may supplement this treatment with transpalpebral electrization, placing the cathode to the closed lid, the anode to the brow or neck, and passing 2 to 4 milliamperes of current for 10 to 15 minutes. The general effect of this plan of treatment has been to induce a speedier termination of the inflammatory process. It is noteworthy, however, that it does not forestall a recurrence or prevent the circular march of episcleritis. New buttons are prone to develop. Together with the electrical, a routine plan of treatment should be used. Fomentations and leeches are very serviceable. The hygienic and constitutional care of the patient must receive due attention.

58. Deep inflammations of the sclerotic coat offer problems that up to the present, electrotherapeutics has not solved. Some of the German ophthalmologists have been successful in isolated cases by the direct use of galvanism. The electrode is of

platinum, flat or slightly concave at its extremity, and measures $\frac{3}{4}$ inch in circumference. It is made the anode and applied directly to the eyeball in the affected area. A current of 1 to $1\frac{1}{2}$ milliamperes is passed through the tissues for 1 minute. The treatment may be continued following an interval of 2 days. It is reasonable to suppose that the sedative effects of the positive pole should exercise a beneficial influence on the inflamed parts, but too often, unfortunately, the results of the treatment are unsatisfactory and disappointing.

DISEASES OF THE UVEAL TRACT

IRITIS AND IRIDOCYCLITIS

59. Inflammatory affections of the ciliary body and iris are not materially modified in their course by electrical applications. We must look rather to routine treatment with atropin and other agents to combat the process. As an aid to routine treatment, however, electricity has found a place. Chief among the results that it will contribute toward bringing about is the relief of *pain*, *photophobia*, and *spasm*. Where these symptoms are intense it will be found that the patient will experience marked relief from faradization, applied with a small sponge-electrode directly to the cornea or through the closed lids with large electrodes. Again, the finger tip of the physician may be made the active electrode and the closed lid gently stroked. The strength of current should in all cases be determined by the sensibility of the patient. Better results are gained by using weak currents for a considerable period of time at each sitting, half an hour or longer. The period of relief appears to depend on the length of time of the sitting. The pain will return, as a rule, after a variable period of quiescence, but yields to repeated faradization. Occasionally, cases rebellious to faradism will be influenced by galvanism. In such instances the anode is to be applied to the closed lids in the form of a broad, moistened electrode and a current of 2 to 3 milliamperes is permitted to pass for a period of 2 to 3 minutes. Faradization, however, will generally accomplish all and more than we may expect from other sources.

60. Electricity finds further utility in this class of cases in *promoting the action of mydriatics and myotics.* In some forms of iritis, particularly of a plastic type, where atropin and eserin fail to produce effect on the pupil, negative cataphoresis will prove serviceable. With the mydriatic or myotic instilled into the eye, apply a constant current of 2 milliamperes to the closed lids. The cathode is made the active pole and the anode is placed on the back of the neck. The duration of this treatment should be from 15 to 30 minutes, in order to obtain the best results. This plan should be used first with atropin and then with eserin.

61. *Absorption of exudates* is hastened by judicious electrical manipulation. Simple hemorrhage into the anterior chamber of the eye seldom requires particular attention. The hemorrhage and purulent exudates resulting from iritis, which fill both chambers of the eye, are often very slowly absorbed. This is the class of cases where we may expect benefit. The treatment is the same as that previously given, with the exception that the mydriatic may be omitted, if desired, and the duration of the application need not exceed 5 minutes at each sitting. The interval between periods of treatment need not be long, 24 hours being amply sufficient. Faradism has been used in iritic hemorrhage, but it is valueless in all cases of intra-iritic bleeding and is available only in simple hyphemia, which condition, also, no doubt, is little influenced by it. Its greatest utility lies in the control of pain and spasm.

62. **Disseminated choroiditis** has been treated by the application of constant currents of mild strength and indifferent polarity through the temples or from the supraorbital notch to the mastoid process of the same side.

DISEASES OF THE VITREOUS HUMOR

63. **Opacities.**—The treatment of vitreous opacities should aim toward the removal of the cause. Specific etiology calls for appropriate constitutional treatment. Local measures generally include leeching and the use of pilocarpin. In the management of opacities of whatever cause, electricity will serve

as a valuable adjuvant. Used alone it frequently fails in its mission. The best results are to be attained by the employment of the stabile constant current of 2 to 4 milliamperes passed either directly through the closed lids to the mastoid process of the same side or through the temples. The poles should be changed frequently. It is well to begin with the anode to the eye and reverse the current during the sitting or at the subsequent visit. Daily applications of 2 to 4 minutes are desirable. It is claimed for faradization that the results of its use are fully equal to those obtained by the method just referred to. We are convinced, however, that galvanism will yield the more satisfactory effects in the general run of opacities resulting from promiscuous causes.

DISEASES OF THE RETINA AND OPTIC NERVE

RETINITIS

64. In view of the claims put forth by the older writers regarding the beneficial effects of electric currents applied to the cervical sympathetic in retinal disease, Rockwell undertook certain experiments in order to ascertain what changes, if any, were produced in the normal retinal circulation by galvanization and faradization of this nerve. In substance, his conclusions were as follows:

1. Galvanism and faradism to the cervical sympathetic may cause contraction of arteries and dilatation of veins.

2. Faradism causes the same effect as galvanism, only more slowly, it being a difference in degree rather than kind.

3. Mild currents and brief applications produce contraction of vessels; strong currents and long applications cause dilatations. Much depends on the temperament and condition of the individual experimented on. What would cause dilatation in one would produce contraction in another.

4. Where the patient is excited or irritable even a mild current may cause dilatation at once.

5. The contraction that takes place is sometimes followed by a dilatation beyond the normal.

6. The dilatation that occurs is followed by a contraction after the close of the experiment.

65. From these experiments it is gathered that while the results of electrical stimulation of the sympathetic are indefinite and unstable, nevertheless there occurs a considerable alteration in blood-flow in each instance. Therefore, as a factor in restoring nutrition to a deceased part, it is valuable. So much controversy has arisen in regard to the utility of this method of treatment that the fairest way to judge of it is by comparative observation of results. If the method be used alone, no good may be expected to accrue. If, on the other hand, it is used in conjunction with other methods, it may be serviceable. This fact is borne out by an investigation of the results of a combined form of treatment. The cases most amenable to electrical methods are those of a *hemorrhagic type.* Albuminuric retinitis gives us less satisfaction. In glycosuric retinitis, with or without scotoma, and in retinitis *pigmentosa,* a combined plan of treatment will serve well. Too much must never be expected from any plan of procedure. The pathology of retinitis shows us plainly enough what a discouraging task lies before us. We may frequently bring about some slight improvement or, at least, arrest the progress of the disease and improve the vision. These ends are worthy of effort.

66. What is meant by a combined treatment will be explained. Stimulation of the cervical sympathetic nerve on the same side as the affected eye alternates with the application of the constant current directly to the eye. This method is as follows: A broad, flat plate, well padded with moistened absorbent cotton, is placed on the back of the patient's neck. The plate is made the anode. The cathode should consist of a dull or probe-pointed metal electrode attached to a handle having a make-and-break arrangement. The cathode is pressed into the soft tissues of the neck in the region of the superior cervical ganglion. A current of 2 to 10 milliamperes may be allowed to pass for a period not longer than 3 minutes. The current may be interrupted several times, if desired. On alternate days the continuous current may be applied directly to

the closed lids. The cathode is the active electrode. A current of 1 to 2 milliamperes should be administered for 5 minutes. This plan of treatment, together with hygienic and constitutional care of the patient, should continue with occasional intermissions for months, or until signs of improvement in the appearance of the fundus and in the patient's vision are manifest.

SEPARATION OF THE RETINA

67. The prognosis in this serious condition is sufficiently unfavorable to warrant affording any rational plan of treatment a trial. Medication is useless. A few instances of spontaneous repair are on record, but this fortunate outcome is never to be relied on. Operative attack has more supporters than any other method. While apparent relief in some cases has followed nearly every variety of operation, it must be understood that no one mode of procedure will suffice for all cases. The same holds good in treatment by electricity. While electrolysis of the subretinal fluid has been successful at times, it has failed at others, and electrocautery-puncture has shared the same fate. Since each of these electrotherapeutic measures has acted favorably, it will be well to speak of each in more detail.

68. The electrolytic needle is used on the principle that sanctions its employment in cases of nævi, aneurism, and hydrocele. There exists between the retina and choroid a collection of fluid that we desire to subject to the electrolytic action of the anode. A suitable needle is requisite. It should be of iridoplatinum, insulated to within 3 millimeters of its tip, at which point a shoulder should project so as to prevent the needle penetrating too deeply into the tissues. This needle is fitted to any convenient round holder and is made the anode. The cathode is to be applied to the back of the neck. The needle is passed through the tunics of the eye with a gentle back-and-forth, rolling motion between the fingers, so as to avoid pressure. The site of introduction should be as near the center of the detachment as possible. The current is gradually raised from 0 to 5 milliamperes and gradually reduced to 0; it is

applied for about 1 minute. A second operation of this character may be performed after the expiration of a fortnight's rest. Some specialists prefer to use bipolar electrolysis, in which case two needles, similar to the one described, are mounted $\frac{1}{8}$ inch apart in an insulated holder. The best results attained are in recent cases.

69. Electrocautery puncture may be single or multiple. The method has the advantage of avoiding choroidal hemorrhage, of being perfectly aseptic, and affording drainage. The operator should possess a fine, rounded, platinum cautery-tip, the shank of which is curved, or bent, to an angle of about 45° to the holder. The site of puncture selected should be as near the equator of the eyeball as possible and equidistant between any two recti muscles. The site will necessarily vary, however, with the position of the detachment. The cautery-tip heated to a white heat is brought to the field of operation. The cocainized eye is steadied by mouse-toothed forceps and the tip is made to burn its way through the coats of the eye into the subretinal space. The instrument should be held in place until a perfectly round hole is formed. More thorough drainage is assured by searing a second or even a third hole into the space near the margin of the separation. The tendency of the separations to recur, owing to the filling of the space through a retinal rent, is in a measure obviated by this plan of treatment.

70. Traumatic anesthesia of the retina is best treated by labile cathode applications of galvanic current to the closed lids.

OPTIC NEURITIS AND ATROPHY

71. The older writers taught that galvanism should be used in all cases, whatsoever the cause. They used the anode to the eye in early stages, and the cathode in the later stages. The currents were weak and the length of applications short. Galvanic currents were also passed through the temples and from before backwards. Considerable enthusiasm prevailed, and

one experimenter taught that fully 50 per cent. of cases of white atrophy were improved. It is probable that this figure was inspired, partially at least, by an overconfidence in a new remedy. The consensus of opinion among the more recent workers is that electrotherapeutic measures are valuable in selected cases only. In optic neuritis of whatever cause, little is to be expected and nothing is gained in the treatment of atrophy due solely to this cause. Simple uncomplicated atrophy may exhibit all indications of arrested progress, while secondary atrophy, due to embolism, syphilis, or retinitis pigmentosa, may be improved by electrization in conjunction with treatment directed to the removal of the cause.

72. The means at our disposal that will accomplish most in the treatment of atrophy are threefold:

1. Local transpalpebral galvanism, the anode to the back of the neck and the cathode to the closed lids. A current of 2 to 4 milliamperes should flow for 2 to 3 minutes.
2. At the subsequent sitting a constant current of equal strength may be passed transversely through the temples for a longer period of time.
3. Occasional galvanization of the cervical sympathetic with a moderate current, placing the anode on the nucha and the cathode over the superior cervical ganglion.

GLAUCOMA

73. Coincident with routine measures and iridectomy, galvanization of the cervical sympathetic is valuable. We desire the sedative action of the current that acts similarly to a division of the nerve. The cathode is applied to the nucha while the anode is placed along the course of the nerve. A current of 12 to 20 milliamperes should be kept flowing for 2 to 5 minutes. The effects are observed promptly. Restlessness and pain are relieved. A palpable diminution of intraocular tension, even in cases of simple chronic glaucoma without iridectomy, will occur and improvement of vision is to be expected.

OCULAR PALSIES AND ASTHENOPIA

74. It is essential in attempting to treat paralysis of the muscles of the eye that we have a correct understanding of the conditions that confront us. One muscle alone may be affected or one nerve that controls a number of muscles. Again, several nerves may be implicated simultaneously. We judge of the position of the lesion causing the paralysis by the grouping of symptoms. For instance, if the internal rectus of one side and the external rectus of the other are affected, we look for the lesion near the nuclei of origin of these nerves or outside the orbit. If the internal rectus of one side alone be paralyzed, we judge that the lesion is in the filament of the third nerve supplying that muscle and is inside the orbit. The character of the lesion is of importance, also. A gumma producing pressure upon a nerve is more amenable to relief than a glioma. In some muscular affections elsewhere in the body electrodiagnosis will serve to clear up conditions sometimes, but in ocular paralyses we have no recourse to it. The main feature in the treatment is the direct excitation of the paralyzed muscle or muscles. Galvanism or faradism may be used. As a rule it will be advisable to make use of both forms of current. The cathode is the active electrode where the former is used. Some practitioners make use of a large moist compress laid upon the closed lids upon which the cathode terminal electrode is placed. It is our belief that better results are to be gained by using small olive-tipped or ball-pointed electrodes. These may be pressed deeply into the conjunctival sac close to the insertions of the muscles. They are available for either galvanization or faradization.

75. Treatment.—The plan of treatment is as follows: The anode is placed to the temple of the side to be treated; a large button-electrode is serviceable. The cathode, in the form of the ball-tipped sound, is thrust deeply into the conjunctival sac in the direction of the insertion of the injured muscle. The current is now turned on, gently at first. By means of an interrupter in the circuit, generally in the handle of the electrode, the operator may close the circuit at will and observe

the resulting contraction. It may be well to judge of the strength of current necessary by watching that which will excite a healthy ocular muscle to contraction. A somewhat stronger current is requisite for the paralyzed muscle. A few contractions, however slight, are sufficient for the first sitting. Longer applications may follow later. As a general rule, the treatment may be given daily. Faradization should alternate with galvanization. The same electrodes may be used. It is well to change the polarity frequently during the faradic séance.

76. Muscular asthenopia, especially with hyperesthetic retina, is a condition that frequently yields most readily to electrization. Mild faradic currents are efficacious, given labile with the anode to the closed lids. The position of the cathode is immaterial. The continuous current is also serviceable. One to 2 milliamperes should be passed through the closed lids for 5 to 10 minutes, changing the polarity once or twice. It is well to alternate the two forms of application.

77. Accommodative asthenopia calls for rest, general treatment, and daily galvanic sittings. The cathode is applied to the closed lids, and a current of 2 to 5 milliamperes is passed for 2 or 3 minutes. Stroking the closed lids with the terminal wire thickly wrapped in moist cotton serves favorably. Mild labile faradizations may properly alternate with the galvanism.

78. Functional hemeralopia is alleviated by mild faradization to the closed lids with the cathode as the active electrode. Daily sittings of 5 minutes each are sufficient. Binocular galvanism with indifferent polarity has been recommended, but the results are slower in appearing, and we are convinced that faradization offers better general effects.

OCULAR NEURALGIAS

79. For the relief of those obstinate and painful affections known as **ocular neuralgias,** no means not directed toward a removal of the exciting cause will yield permanent results. Paroxysms of distress may be quickly quieted by the sedative

action of the galvanic current, but the respite is only temporary. A current of 2 to 6 milliamperes should pass through the tissues of the lids, brow, and face from the anode terminal. The cathode may be placed on the mastoid or the neck. The duration of the galvanization should occupy about 5 minutes.

VASCULAR TUMORS OF THE ORBIT

80. The general rules laid down for the treatment of **vascular tumors** of the lids and face apply equally well for similar growths in the orbit. Electrolysis offers a safe and efficient means for removal and one that does not disfigure. The bipolar method has received the sanction of the majority of operators and is the best. The needles should be of irido-platinum and lance-pointed. Curved needles may be serviceable at times. They will require insulation to an extent varying with the requirements of each case. A coating of shellac or collodion will furnish all insulation necessary. Where the tumor is small the needles may be mounted in an ordinary bipolar handle, but where the growth has attained some magnitude it is better to use two needle-holders. The cathode needle may be inserted into the tissues of the mass and allowed to remain in one spot while the anode is passed in various directions at one operation. It will not be amiss to repeat a word of caution in regard to insulating the needles sufficiently to guard against electrolyzing the tissues other than those composing the tumor. It is difficult to fix definite limits to the strength of current to be used. The practitioner must be guided largely by the individual case. Generally speaking, the current should not exceed 15 milliamperes, and the time of application need not go beyond 10 minutes. An interval of several days should elapse before electrolysis is repeated, if a second operation is deemed essential.

LOCATION OF FRAGMENTS OF METAL IN THE EYE BY MEANS OF X-, OR ROENTGEN, RAYS

81. Hand in hand with the improvements in apparatus, the technique of locating pieces of metal in the orbit has advanced so that at the present time experts are able to determine their position with mathematical certainty. The tissues of the eyeball itself offer great resistance to the passage of rays, and this resistance is naturally increased by the bony framework of the orbit. The eye is so situated that no exposure can be made without including some of the neighboring bones, and the problem that confronts us is to reduce the bony shadows to a minimum. It has been determined by experimentation that the path of least resistance lies in a line passing across or partly through the nasal bones and through the orbit to the temple. Anteroposterior and vertical exposures are inadequate. The source of the rays must start from the side opposite the injured eye, and the skiagraphic plate should be attached to the temple adjacent to the injured eye. In this manner the clearest skiagraphs are obtained. The greatest manipulative skill is necessary in this work and no one not an expert in Roentgen ray methods should attempt it. It will be unnecessary to give in detail all the modifications of procedure, but one of the best methods will be outlined rather explicitly. The method is that of Dr. Wm. M. Sweet, of Philadelphia, to whose writings* we are indebted for material and illustrations.

82. The tubes that generate the rays should be of high-vacuum pattern with resistance sufficiently low to avoid interruptions of the rays and allow a steady generation. Fig. 35 shows a Queen's self-regulating tube that operates in the following manner: The larger tube has a high vacuum and offers high resistance. The smaller tube is one of moderate vacuum that has leading into it from the larger tube a bulb containing potassium hydrate. Leading to the smaller tube is a hinged metal rod *B*. It is also provided with a cathode-terminal from

*Trans. Amer. Ophth. Sec., Vol. VIII, Pt. 1, Page 91.
Arch. of Ophth., Vol. XXVII, No. IV, Page 377.

which the current jumps to the bulb, heating the potassium hydrate until it gives off gas, which lowers the vacuum in the large tube. As the potash cools the gas is reabsorbed. *A B* is a spark-gap, usually adjusted to 4 inches, across which the charge occasionally passes and maintains a steady vacuum in the larger tube. An induction-coil is used, which is supplied by the ordinary constant-current lighting circuit, controlled by a rheostat.

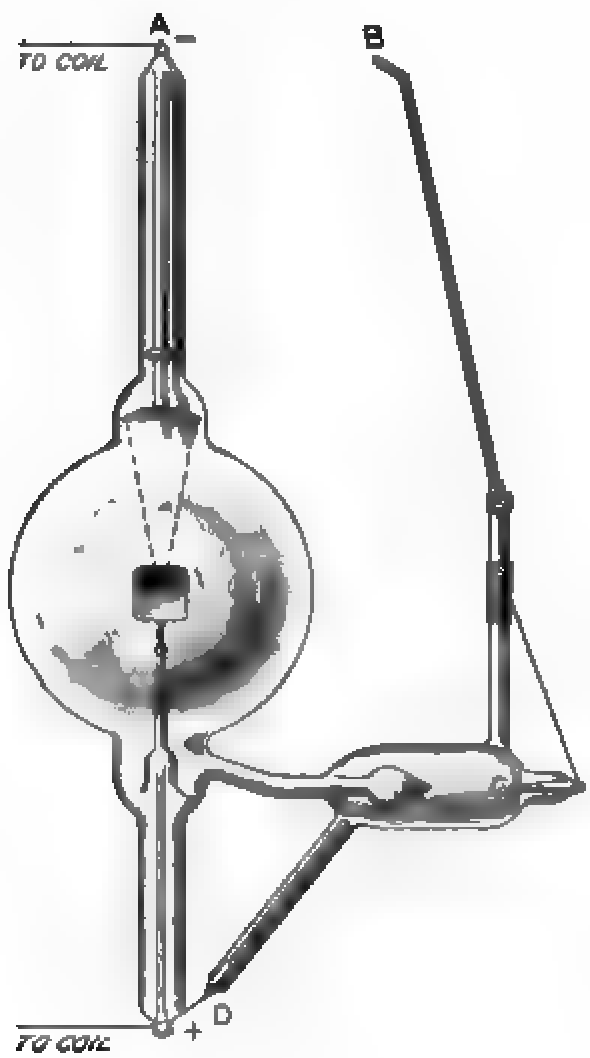

FIG. 35
A Crookes Tube of Special Pattern for Eye-Work

83. To assist in locating the foreign body, two parallel, ball-tipped, metallic indicators are used. These indicators are at a given distance apart, one pointing directly to the center of the cornea, the other to the temporal side of the eye. The site of the body is calculated by means of the relations between the shadows of the body and the indicators. Two exposures are necessary, one with the tube horizontal, in the plane of the indicators, the other at a distance below it. Fig. 36 is a diagrammatic scheme of the principle. Letting the candle-flame represent the Crookes tube, the surface *C* represents the shadows of the indicators and body on the photographic plate when the tube is in the first of the two positions spoken of *A*. When the tube is in the second position *B*, the shadows are thrown on the plate as shown on the surface *D*. If we know the distance of one indicator from the cornea, which may be regulated by the operator, and that between the indicators, which is fixed, the position of the metal body may be calculated, because its

shadow maintains fixed relations with the shadows of the indicators, no matter in what position the tube is placed. It is necessary also that the indicators be parallel with the axis of the eyeball and parallel to the skiagraphic plate. These requisites have been conveniently combined, as shown in Fig. 37. The patient is placed in the prone posture during the exposure. Two radiographs should be taken, as above indicated. Four minutes is a sufficient length of time for each exposure.

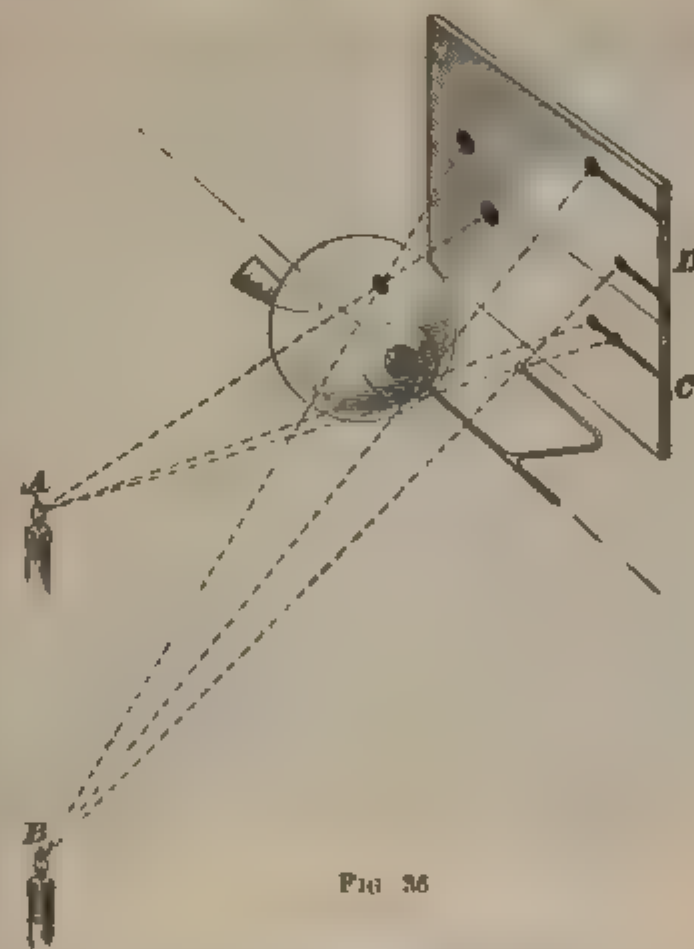

FIG 36

FIG 37
Showing Position of Plate and Indicators

84. Let us now suppose that we have the skiagraphs showing the shadows of the body and indicators (see Figs 38 and 39). The distances between the shadows of the body and indicators are to be measured in each, as well as the distance of the body

FIG. [illegible]

Skiagraph Made With Tube at [illegible]

FIG. [illegible]

Skiagraph Made With Tube at [illegible]

above or below the indicators. For convenience sake, these relations may be outlined as shown in Figs. 40 and 41.* Now, to ascertain the position of the body in the eye, draw on paper two circles, each 24 millimeters in diameter. Let the lower one represent a vertical section of the eye and the upper one a horizontal section (see Fig. 42). The point A at the center of the vertical circle represents the center indicator, and the point B, the temporal indicator. The line $A\,B$ is the exact distance between the indicators. On the horizontal circle a point is made

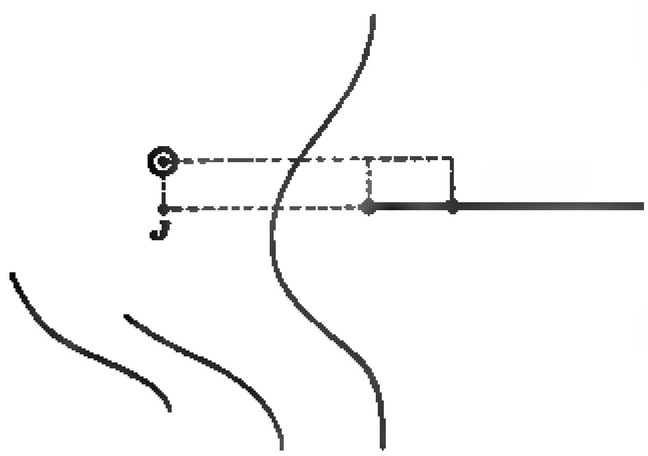

FIG. 40
Schematic Representation of Fig. 38

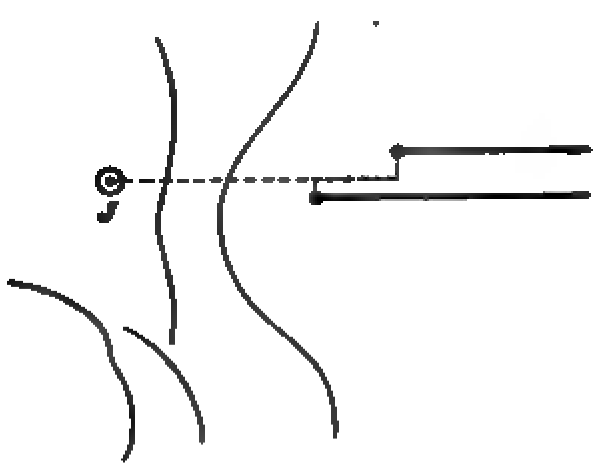

FIG. 41
Schematic Representation of Fig. 39

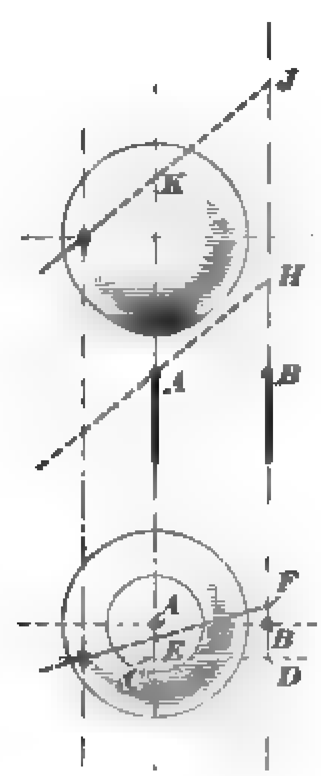

FIG. 42

in front of the center of the cornea at a distance equal to that between the indicator and the center of the cornea at the time of the exposure. A and B will represent the indicators, and $A\,B$ the distance between them. The distances of the shadows of the body above or below the indicators, $A\,C$ and $B\,D$ in the

* In order to understand the relative positions of the shadows belonging to the indicators and the foreign body, it should be remembered, that when a photographic print is taken of a skiagraph the left side is changed to right and vice versa.

one case and $A\ E$ and $B\ F$ in the other, are marked above and below the points of the indicators in the vertical section. In the diagram they are below in each case. The line $C\ D$ shows the direction of the rays at the first exposure, and $E\ F$ the direction of rays at the second exposure. The intersection of these lines marks the site of the foreign body with reference to the temporal or nasal side and above or below the horizontal plane of the eyeball. Now mark above the external indicator on the horizontal diagram the measurement of the distance between the shadows of the two indicators, as shown in the horizontal exposure. Draw a line from this point H through the center indicator. $A\ H$ is the line showing the direction of the rays. The distances from each indicator, on the same exposure, to the shadow of the body are to be marked on the same diagram perpendicular to A and B. These points are K and J. The line $J\ K$ shows the plane of the shadow of the foreign body, and the point of intersection of that line with another perpendicular to the position of the body, as found in the vertical section, marks the position of the body in relation to its distance posterior to the cornea. With, therefore, the relative distances of the foreign body in millimeters or fractions of an inch, it becomes a much simpler matter to attempt its extraction. No complications resulting from exposures to the Roentgen rays beyond a transient dermatitis can be said to arise.

REMOVAL OF PARTICLES OF IRON OR STEEL FROM THE EYE BY THE ELECTROMAGNET

85. Pieces of iron or steel that have found lodgment in the conjunctival sac may be easily removed by the use of the spud or by the electromagnet. Where particles have penetrated the tunics of the eye itself, the affair assumes a much more serious aspect. The magnet may be successful in removing the foreign body but several requisites are necessary. The magnet itself must be powerful enough to dislodge the particle from the tissues in which it may be embedded. The magnet must be brought as near as possible to the fragment. If the tip of the magnet can be introduced through the wound of entrance, so

much is gained; but if the wound is not large enough, it must be aseptically enlarged or a point of entrance made if none be visible or accessible.

86. For ordinary use, Johnson's portable magnet is serviceable. The instrument is 7½ inches long. It is wound with 2 pounds 10 ounces of No. 27 single, silk-covered, magnet wire. The total weight is 3½ pounds. Two tips are provided, one ovoid in form and ½ inch long, the other elongated, having a diameter of $\frac{3}{32}$ inch. This magnet has sufficient internal resistance to permit its excitation with the ordinary 110-volt current. Hirschberg's magnet, Fig. 23, is quite powerful, and is the one most frequently used in the extraction of steel particles that have penetrated the eye. The apparatus comprises the magnet and several adjustable tips of different forms. Haab's magnet, Fig. 24, is the most powerful of all. It consists of a soft-iron cylinder 60 centimeters long and 10 centimeters in diameter, terminating in a conical tip at each end. This core is surrounded by a coil of copper wire 5 centimeters thick. The instrument turns on a vertical pivot. It is excited by any source of constant current, provided the voltage is somewhere between 60 and 120. In connection with the circuit before the apparatus, is a bipolar interrupter and a safety arrangement. The conical tip is brought as near the particle to be removed as possible. To this end the patient is generally brought to the instrument in a high chair in such a position that the tip is just in contact with the wound of entrance or with the embedded particle. The extraction of foreign bodies by this method is quite painful, as a rule.

ELECTRIC OPHTHALMIA

87. Before closing the subject of the electrical treatment of diseases of the eye, it may be well to mention a disorder produced by the effects of electric light. **Ophthalmia** is never due to the ordinary use of the incandescent lamp, and we must look to the more intense forms of the electric light, such as the arc-light, for the exciting cause. Some electricians and employes who are obliged to work near a cluster of arc-lights will suffer from the results. The disease occurs chiefly among electric

welders, whose vocation necessitates exposure of the eyes to an intense glare.

The symptoms are almost identical with snow-blindness. They appear promptly after exposure, as a rule; usually within a day. The pupils are contracted, and the lids may be swollen and the seat of some edema. During the course of the affection there is usually a slight mucopurulent discharge from the conjunctiva. Recovery is expected within a few days. The rule is that vision is completely restored after the subsidence of all symptoms, yet rare exceptions show that occasional impairment may occur. A persistent central scotoma is an occasional sequel.

RETINAL BLINDING

88. Retinal blinding is the same affection as the blinding by sunlight. Certain experiments go to show that electric lights can produce changes in the retina without heat-coagulation. The changes referred to consist principally of edema with some destruction of nerve-cells in the outer layers, including the rods and cones. The inner layer of nerve-fibers may escape or may be involved as well. The harmful action of the light is attributed to a dazzling of the retina and to the chemical action of the ultraviolet rays. The heat rays may also have some influence.

The treatment is that for snow-blindness. Yellow goggles are useful, or combinations of red and dark blue may be substituted.

DISEASES OF THE EAR

INTRODUCTION

89. The earlier investigators in electrotherapeutics, with reference to diseases of the aural apparatus, were enthusiastic in their praise of the efficacy of the treatment. The literature is full of the results of their labors, but one must search quite in vain for the teachings of modern authors on the subject. It is a fact too often noted in the employment of an agent that after a full swing toward the side of utilization the pendulum vibrates as far toward the side of neglect. The present time

seems to be synchronous with the latter movement. An interval of time, which shall be devoted to a sober consideration of the value of a remedy, will be necessary to restore a middle ground between the two extremes. Positive opinions, therefore, as to the availability of electrotherapeutics must be held in abeyance until a more systematic effort has been made to place it in a sphere wherein its deserved merits will be attested.

90. Before entering upon a discussion of the various diseases of the ear toward which the treatment is aimed, it will be advisable to sound a note of warning as to the limitations of the subject. To begin with, we are aware of the depth of the parts beneath the surface and of their inaccessibility, the close association of the auditory nerve with the nerve of motion to the facial muscles, and the relations of the organ to the pharynx. Such an arrangement of structures demands for the relief of disease the application of principles based on the fullest appreciation of the physiology and pathology of the tissues. The laws applicable to the reaction of nerves to electric stimulation apply to this nerve of special sense in a characteristic manner but within definite and prescribed limits. The effects of such stimuli are shown in subjective sensations of sound and not by movements of muscles, as is the case with motor nerves. The ear has a double function, that of hearing and that of equilibration, and it is difficult to influence the nerve-filaments that govern one function without, at the same time, producing effects on the other, since these filaments together constitute the trunk of the nerve. Too much must not be expected of electric treatment directed to diseases of the nerve itself. It is in conditions affecting the external and middle portions of the ear that electrotherapeutics finds its chief utility. We make use of galvanism, faradism, static electricity, and electrolysis. The Roentgen rays are valuable in locating foreign bodies in the deeper portions of the auditory tract, where ordinary illumination is of no avail.

AFFECTIONS OF THE EXTERNAL EAR

ABNORMAL DRYNESS OF THE CANAL

91. Where the abnormal dryness of the canal is due to a lack of secretion of cerumen, it is benefited by recourse to the following procedure: Under a clear illumination of the passage with the reflector and speculum, gently remove all flakes of dried secretion and cleanse the parts thoroughly with warm water and the syringe, if necessary. Place the patient in a sitting posture beside a table, with the head pillowed sidewise upon it, the ear to be treated being uppermost. Fill the canal with normal salt-solution. Place the anode, in the form of a broad, well-moistened pad, on the patient's neck. A probe-pointed electrode of any pattern or the terminal battery wire, itself, will serve as the cathode, which is to be immersed in the water in the ear to the depth of ½ inch. Throw sufficient resistance into the circuit beforehand so that no reading is to be had from the milliammeter, and when the cathode is in position, gradually allow the current to augment until 2 or 3 milliamperes is attained. Continue the electrization for 4 or 5 minutes, gradually withdraw the current, and remove the electrodes. Allow the salt-solution to drain away, and wipe dry the external portion of the canal. This treatment may be repeated three times a week until the speculum shows a decided improvement. It is to be borne in mind that the current should never be of considerable strength when the cathode is serving as the active electrode, for reasons that will be apparent when we come to consider the effects of electricity on the auditory nerve, and that all abrupt fluctuations of current should be avoided.

92. To promote the *action of cocain* in anesthetizing the external passage and the drum, the constant current is of service. Place the patient in the posture just described, and fill the external ear with a fresh solution of cocain of 10-per-cent. strength. The cathode is placed on the patient's neck or over the mastoid on the side to be treated. A padded disk or

cup-shaped electrode will serve the purpose. The anode consists of a probe-pointed metal electrode, which is partially submerged in the cocain-solution. A current of 4 to 5 milliamperes is gradually attained and permitted to flow for 3 or 4 minutes. At the end of that time the anesthesia will be found to be complete, as a rule, and the current should be checked and the electrodes removed. If it is desirable to keep the patient in the same position for operation, the cocain-solution may be removed by cotton swabs.

STENOSIS OF THE EXTERNAL AUDITORY CANAL

93. Partial or complete occlusion of the external canal may be due to a variety of causes, on which depend the choice of agents for its amelioration and the methods of their application. The narrowing that results from *cicatricial contraction* following a local ulceration, or otitis media, will yield to cathodal electrolysis properly applied. On the other hand, a stricture due to *organized inflammatory deposits* calls for the particular electrolytic effects that the anode affords. The same may be said of narrowing due to *vascular growths*, or *nævi*. Malignant tumors are seldom the cause of stricture in this situation.

Electricity is of no avail in the treatment of stenosis due to congenital malformations. Electrical treatment should give way to surgical measures wherever, in the opinion of the operator, more permanent improvement is to be derived from it. In ordinary cases, however, electrolysis will serve the purpose to a better advantage.

In cases of *annular strictures* complicating or resulting from otitis media, the treatment by incision or excision of the ring, followed by the use of tents, should not be used. The tents cause constant suffering and are conducive to foulness and sepsis. The discharges are dammed back by them and their use is frequently followed by mastoid complications.

94. Electrolysis affords a safe, clean, and reliable agent for the treatment of such conditions. The ear may be anesthetized by the plan previously referred to, or the patient may decline all analgesics. A general anesthetic is scarcely necessary. The

operator will require a flat, well-padded, and moistened electrode to serve as the anode, and a needle of iridoplatinum of convenient length, which may be made the cathode, or active electrode. Place the anode on the back of the patient's neck. With the auditory canal well illuminated and the patient's head steadied at a height convenient to the eye of the operator, the needle is passed into the tissues composing the ring at a distance of about ¼ inch from the lumen. It is desirable to commence at a definite point, so that we may progress entirely and regularly about the periphery with punctures at subsequent sittings; in this manner the entire mass is attacked with system. The current should now be gradually raised until the milliammeter registers 4 or 5 milliamperes. This strength is to be maintained for 4 or 5 minutes and then slowly reduced to zero.

FIG. 43
Circular and Longitudinal Sections of Aural Stricture Showing Plan of Attack

The needle is then withdrawn and a light dressing of acetanilid or nosophen with aseptic gauze applied. There is, ordinarily, only a very slight inflammatory reaction following the treatment, and this quickly subsides. It is needless to state that the ear should be rendered as nearly aseptic as possible before the operation. Treatment may be continued after an interval of 2 or 3 days.

Fig. 43 shows vertical and horizontal sections of the stricture, with the needle in position and the dots indicating the location of the electrolytic punctures. By the time the entire circumference has been subjected to electrolytic treatment, the lumen of the passage will be found to be materially enlarged.

DISEASES OF THE MIDDLE EAR

OPACITIES OF THE TYMPANUM

95. Good effects are obtained by the use of a constant current after the manner indicated under the heading Abnormal Dryness of the Canal. An exception may be made as regards the polarity since, in drum opacities, we may gain better results by changing poles either during the sitting or at alternate sittings. Weak currents are desirable, and a strength of more than 2 milliamperes is not required. The treatment should cover an indefinite period of time, or until signs of improvement in the appearance of the tympanic membrane are marked.

OTITIS MEDIA

96. As an adjunct to the routine and systematic treatment of otitis media, electricity is of value. It cannot be said for it that it is in any sense curative, but that mild constant currents exercise a stimulating effect on chronic ulcerative processes and indolent suppurative conditions of the ear, cannot be denied. The affected ear is first thoroughly cleansed and freed from all discharge. A pin-point aperture in the drum is to be enlarged, so as to permit free drainage and douching. With the ear filled with saline-solution, the cathode is partially immersed and a current of 1 to 2 milliamperes allowed to flow for 1 minute. An aural metal sound, wrapped in cotton or left bare, will serve as the active electrode. The poles may be changed occasionally to advantage. Weak currents for short periods is the rule. Gentle swabbing of the parts, under illumination, with the cathode wrapped with cotton may occasionally take the place of the procedure already referred to. Topical applications of any character may follow the electrization.

97. The deafness that is due to an old middle-ear disease with *ankylosis of the ossicles* is occasionally relieved by faradism. This form of electrization is available on account of its mechanical effect on the bones. The electrodes and the mode of

application are the same as in otitis media. The interrupted current should never be strong. The patient may even complain, during the administration of very mild currents, of unpleasant reflex phenomena, such as dizziness, due to a disturbance of the semicircular canals, and a cough, due, possibly, to a stimulation of Arnold's nerve.

Static sparks may be used, and not without advantage, in ear-diseases where the bones are undergoing ankylosis but where the union is not yet firm.

98. The affections of the Eustachian canal, while falling properly under the section devoted to diseases of the ear, will receive consideration when we come to discuss diseases of the throat.

DISEASES OF THE INTERNAL EAR

99. The entire subject of the electrical treatment of diseases of the internal ear needs careful study. From a review of the evidence before us we must conclude that it is of little avail beyond a limited utility in some of the forms of tinnitus and deafness. By virtue of the effect of an electric current on the eighth nerve, under normal conditions, we are able to obtain some light as to the state of the nerve itself. The nerve possesses a normal degree of excitability that may vary or become altered by disease. For instance, drum-perforations and some forms of labyrinthine diseases lead to an abnormal degree of excitability—a pathological increase. On the other hand, some forms of diseases of the labyrinth lead to a pathological diminution of excitability and point to neuritis, particularly if accompanied by tinnitus. The electric current gradually increases the excitability of the nerve. All shocks are decidedly harmful. A stimulation of the nerve results in subjective sounds, a fact that is utilized by practitioners as an aid to *diagnosis* in aural affections. If we place one electrode on the patient's neck and the other on the tragus of one ear, and allow a current of 4 to 6 milliamperes to pass, we shall obtain different sounds, depending on the interruptions of the circuit. The character of the sounds may be buzzing, roaring, or whistling.

100. The behavior of the eighth nerve corresponds to the requirements of Pflüger's law: "A nerve is excited by the appearance of catelectrotonus and the disappearance of anelectrotonus, but not by the appearance of anelectrotonus or by the disappearance of catelectrotonus." The formula for the sounds obtained is as follows:

C. C. S. = cathodal closing sound, a distinct accentuated sound.
C. D. > = cathodal duration, the sound continuing to disappear gradually and by degrees.
C. O. = cathodal opening, no sound.
A. C. = anodal closing, no sound.
A. D. = anodal duration, no sound.
A. O. S. = anodal opening sound, feeble sound.

It is unfortunate that results so definite as these do not offer to us clear indications as regards the treatment of nerve-affections. It must be admitted that they are not infallible guides.

SIMPLE GALVANIC HYPERESTHESIA

101. Simple galvanic hyperesthesia is a term applied to a moderate hyperesthesia of the auditory nerve that leads to an increase of the normal formula. A high grade of hyperesthesia gives what is known as the *paradox* formula and is characterized by a curious phenomenon. If we apply the examining electrode to one ear only, the unexamined ear reacts as if it were influenced by the indifferent electrode. The indifferent electrode may be in the patient's hand or on the sternum, and the effects will be the same. It is an expression of a very high degree of galvanic irritability and has no further significance. It affords a hint to us in the treatment that we should arm both ears with one divided electrode. Any alteration of the formula necessarily indicates a disease of the nerve itself, and in all such cases the constant current may be afforded a trial. There is little to be said in favor of it. The conditions wherein it is serviceable will be distinctly pointed out.

TINNITUS AURIUM

102. Tinnitus aurium may be due to a variety of causes, and in each case the etiological factors should be attacked if one desires to cure the affection. By this alone will any definite results be attained. Some cases are incurable, but many of the most persistent and intractable may be ameliorated by patient effort.

In the first place, the physician should ascertain by means of the formula whether or not the sounds are due to disease or irritation of the auditory nerve. If the sounds are normal, it may be assumed, though not conclusively, that the nerve is normal. If the sounds heard by the patient during the examination are *with* the formula, good results may be obtained. The active electrode is generally an ordinary aural sound well wrapped with moist cotton, and so placed upon the tragus as not to occlude the external meatus. The duration of the sitting must be governed largely by the subjective sense of the patient. Frequently, the noises cease directly on starting the current, in which case the applications need not consume much time; but in some instances they cease only after a considerable continuance of the current. The time necessary for a single sitting may vary, therefore, between 5 and 25 minutes, approximately. The rheostat should be made gradually to withdraw the current until the milliammeter rests at zero before the electrodes are withdrawn.

103. Tinnitus, which is associated with hyperesthesia and with experimental sounds *against* the formula, is oftenest relieved by *C. C.* and *C. D.*

Tinnitus, associated with nervous deafness and deafness without any discoverable lesion, but with altered formula, may be greatly improved or even cured by this plan of treatment. Generally speaking, it may be said that where, in such cases, the formula is normal the anode is the active electrode, and where the reaction is anomalous the cathode should be used. The galvanic reaction must always be tested. It has been recommended to fill the ear with saline-solution and to immerse the electrode in the fluid, but the procedure is apt to modify

the sounds or to give rise to adventitious noises that confuse both patient and operator. The position of the indifferent electrode is of minor importance, so long as it is remote from the unengaged ear. Should the tinnitus be found associated with a paradox formula, we must make use of a binaural electrode. It has been suggested that an ordinary stethoscope be used for this purpose.

104. The patient is advised always to pay close attention to the sounds he hears during the treatment. He is the sole index of the correctness of the work. Some idea as regards the prognosis in a given case may be gained by the results of the first sitting. We shall suppose a man to have tinnitus with normal formula. If the sounds cease or diminish on the application of the anode, the operator may feel encouraged. The outlook is bad if the sounds are unchanged in character or intensity. Treatment may be given daily for a week and three times a week for 2 or 3 weeks following.

Tinnitus, which is due to middle-ear disease, is generally relieved by Eustachian catheterization and routine methods. The stubborn cases associated with ankylosis of the ossicles are sometimes favorably influenced by faradism.

105. Some of the French specialists have used cupric diffusion or cataphoresis in the treatment of ringing in the ears due to an abnormally dry condition of the nasopharynx. A copper bulb is the active electrode and is connected to the anode terminal. The bulb is introduced, usually through the nasal passage, into the nasopharynx. From 8 to 12 milliamperes of current are allowed to pass for 5 minutes.

The static *souffle*, applied either directly to the ear or indirectly to the pharynx through the open mouth, has given relief in some cases which were not benefited by other forms of treatment.

Electrotherapeutics has failed to establish itself as an available agent in the treatment of *deafness*. Faradic currents of moderate intensity are valuable in deafness of the neurotic type, but in that due to labyrinthine disorders and to middle-ear diseases there is little to be gained by electricity in any form.

the continued irritation and inflammation, the areolar and submucous tissue becomes engorged with leucocytes and pus-cells, which, together with serum and glandular products, give rise to the discharge from the nose. The preponderance of any one of the concomitants of the exudation will determine the character of the secretion, whether it is serous, mucopurulent, or decidedly purulent. The blood-sinuses of the turbinate bodies partake of the morbid changes to some extent. The symptoms do not require mention. To the specialist who takes pains to examine every case which presents itself, as a routine measure, the picture of the nasal chambers is quite characteristic. While the tissues respond, after a manner, to the nature of the exciting cause, a fairly uniform condition is found. Examination of the anterior and posterior nares shows a mucous membrane covered with secretions more or less ropy and purulent. Upon wiping or cleaning the parts with the douche the mucosa appears dark red and swollen, and the tissues pit on pressure and perhaps bleed easily to the touch.

Confronted by such a picture, which represents a definite pathological condition, the physician must realize that successful treatment will depend on certain factors. In the first place, measures directed toward relief must take cognizance of the exciting cause and remove it if possible. Then it must be borne in mind that the routine agents, such as cleansing and antiseptic and astringent powders, bougies, and solutions, while admirable as palliatives, do not contribute toward permanent alleviation. Their use must be persisted in for long periods of time, and at their discontinuance the tissues are prone to relapse into their chronic state. Radical measures are necessary. The parts must be so handled that organized tissue may bind down or shrink the distended structures, and the agent that will best contribute to this end is an escharotic. Better than nitric acid or other remedies is the electrocautery, which, applied to the tissues, will produce scar-tissue that by its contraction will permanently modify the conditions present.

111. Treatment.—The cautery-tip shown in Fig. 44 will answer or one similar to those shown in Fig. 33 will suffice. The

cautery-apparatus must be in good order and the current so modified as to yield a cherry heat upon closure of the circuit. The nasal chamber to be operated on is to be thoroughly cleansed with a mild alkaline spray and cocainized with a 4- to 6-per-cent. solution. The operator dilates the anterior nares, and with the cold tip of the cautery marks out the spots upon the mucosa which he is to attack. Fig. 46 shows a section of a chamber that is affected with chronic rhinitis. The X-marks roughly designate the areas to be touched. The heated tip is now brought into service, and its edge is introduced into the most prominent parts of the tissues, deep enough to penetrate to the submucous structures. The punctures should be as few and as far apart as possible. Following the cauterizations, the chamber should receive daily treatment with cleansing solutions and oily sprays.

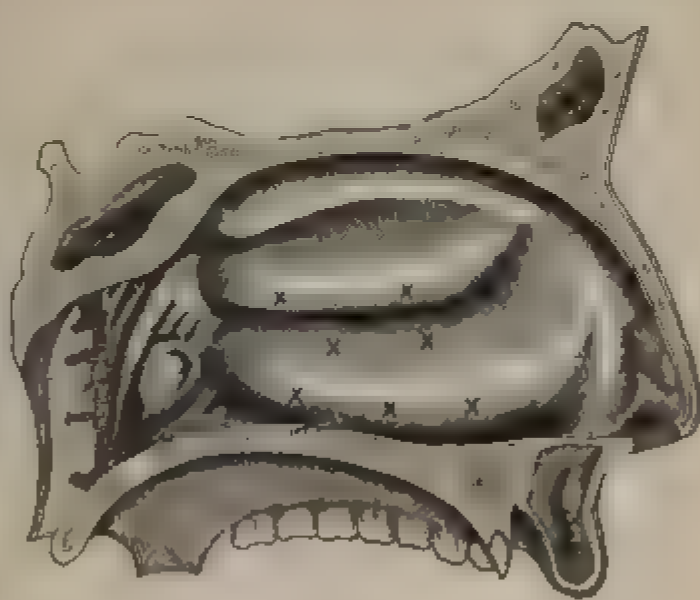

FIG. 46

Chronic Rhinitis

112. It will be necessary to speak of the complications that occasionally arise following the use of the electrocautery. The instrument is in itself sterile but the difficulty of maintaining thorough asepsis of the nasal cavities is considerable. Inflammation of the middle ear, thrombosis of the accessory sinuses, erysipelas, mastoid disease, and septic meningitis have followed cauterization, and the operator should bear these facts in mind. In addition, there is frequently a tendency for adhesions to form between the burned spots and the septum, particularly when these areas are in close proximity. To guard against this undesired sequel, the parts should be inspected frequently and any bridges broken down. If the tendency to

unite is apparent, the two portions may be kept apart by small cotton-tampons moistened with camphorated oil or sterile vaseline. Neglect of these precautions will contribute toward firm synechia between the septum and turbinates and annul the good which one seeks to accomplish. In all operative measures upon the turbinates that necessitate the use of escharotics the practitioner must scrupulously avoid injury to the septum.

HYPERTROPHIC RHINITIS

113. Nature.—The two preceding affections lay the foundation for the hypertrophic variety of rhinitis, although in rare instances no apparent cause is at hand. Such instances of idiopathic hypertrophy are very rare. There are many symptoms and appearances common to this condition and to simple chronic inflammation, and it is essential that a complete differentiation between the two disorders be made. To accomplish this, routine examinations of each case should be made. It has previously been observed that chronic inflammatory troubles of the nasal mucosa were accompanied by a considerable thickening or tumefaction. In the present instance this thickening has reached a stage wherein not only the mucous membrane but the submucous tissue and the "corpora cavernosa" are involved as well. The increase consists largely in connective tissue and the elements that go to form it, which becomes vascularized and organized, and all the normal structures are proportionately increased. In the examination of such a case it will be observed that the increase is scarcely uniform. Some parts are more thickened than others and this gives an uneven appearance to the structures. The turbinate bodies seem greatly enlarged. The lower turbinate may fill the entire lower meatus and the middle one may project horizontally so far as to touch upon and ulcerate the septum. In simple chronic rhinitis we said that the tissues pitted on pressure, but in the hypertrophic variety there is no pitting. So elastic are the structures that they spring back into position as soon as pressure is removed. Hypertrophies that occur anteriorly have an appearance different from those situated near the posterior nares. The former may be dark red or nearly normal in color, while the latter

are usually purplish or quite light in color The posterior thickenings assume a mulberry outline as a rule, while no particular shape characterizes the anterior enlargements. The proliferation of tissue is not always limited to the turbinates. The septum may share the process (see Fig. 47). The secretions are considerable. The contractile power of the tissues

FIG. 47

Hypertrophic Rhinitis

as compared with that in chronic rhinitis is almost wanting. The application of a solution of cocain may clear up the nature of a case that has rested in doubt. Where the organization of the fibrous tissue is lacking the parts will shrink to their natural size or nearly so.

114. Treatment.—From what we have said in regard to the pathology of hypertrophic conditions it is obvious that palliative treatment is of no avail and that radical measures only will efficiently serve The object aimed at in the treatment is to produce an eschar of such shape, magnitude, and depth as to cause, by the subsequent contraction of the resulting scar-tissue, a shrinkage in the parts Since the character and size of the hypertrophies vary with the location in the nasal chamber it follows that therapeutic measures must undergo modifications. The anterior hypertrophies generally require the escharotic and no more, but the posterior enlargements most frequently demand the entire removal of a portion

...wn until it lies within the speculum, when ...ed, and as soon as the heat has reached the ... instrument is carried quickly to the proper site ... made to puncture the tissues well down through ...and submucous structures. If the area to be cau... ...longated, the puncture should assume more the ...f an incision. Just as soon as the cauterization is ... the circuit should be broken and the tip withdrawn ... the reaction is usually very mild. Occasionally, an ...mation of some magnitude is set up, but such a complica... ...is rare and usually subsides without giving rise to serious ...ble. The patient should be seen daily for a week follow...g the operation. Alkaline douches, oily sprays, and the prevention of synechia constitute the ordinary after-treatment. A week should always elapse before operative steps are resumed.

116. Removal of Tumors.—It frequently happens that intumescent masses occur coincident with the ordinary broad or narrow hypertrophies. These may also be present to the exclusion of other varieties of enlargement, but in either case their treatment is the same. Electrolysis offers the best means for their removal. As we recall the pathological conditions present, the engorged and dilated vessels and sinuses, and the newly organized growth with its own vascular supply, it will be apparent that the electrolytic needle must bring about a coagulation of the vessels and cut off the blood-supply of the parts in order to produce lasting effects. We therefore select the anode as the active electrode. An iridoplatinum needle suitably mounted in a convenient holder should be employed. For tumors of ordinary size the monopolar method is most serviceable, whereas if the masses are very large, the bipolar treatment should be used. The method of application is

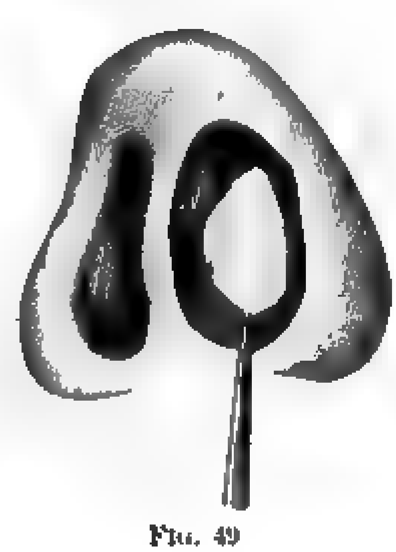

FIG. 49
Showing Intumescence and Electrolytic Needle in Position

of steadying the growth and preventing the snare from slipping is requisite. Jarvis needles serve the purpose admirably

119. To apply the snare, dilate the anterior naris under good light and apply solutions of cocain and adrenalin hydrochlorid. Transfix the hypertrophy about midway between base and summit with a Jarvis needle. Thread the loop of the snare over the handle and blade of the needle and draw it snugly to the mass to be removed. As soon as all is in place close the circuit and tighten the loop by means of the nut, screw, or trigger in the handle (see Fig. 53). A portion of the redundant tissue is thus removed. There is no hemorrhage and the wound closes, as a rule, in a few days. Routine measures of antisepsis should never be neglected following an operation of any character.

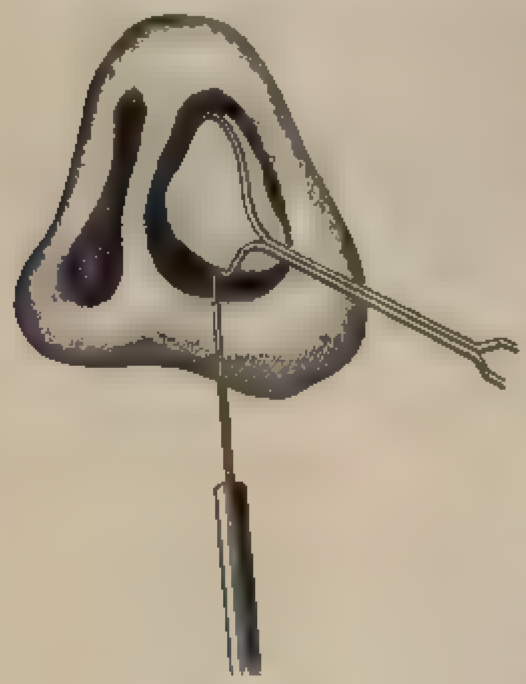

FIG. 53

120. Rhinoscopic Mirror.—In the diagnosis and treatment of postnasal hypertrophies the rhinoscopic mirror is indispensable. It is essential to obtain a clear image of the posterior nares, and in persons with sensitive throats, this is not always easy. A cocain spray (10 per cent) will facilitate matters materially. Having made a complete diagnosis of the conditions present, it devolves upon the specialist to remove the mulberry, or polypoid masses that block the posterior nasal chambers By means of a flexible bougie or a Bellocq cannula, introduce a long, narrow piece of sterile tape or gauze through the mouth and out along the nasal floor and tie the extremities at the upper lip. This holds the soft palate and uvula well forward and out of the way. Under steady illumination, place the rhinoscopic mirror in position and hold it there while the cold electrocautery-snare is introduced into the nasal passage of

one side—the side to be operated on. By means of the image in the mirror (see Fig. 54) the operator is able to see that the loop is perfectly adjusted to the mass, and is in a position to sever the tissues in a direction from behind forward [see Fig. 54 (a)]. The circuit is now to be closed and the loop drawn home. The circuit is then opened and the instruments are removed. The operation is almost painless. For a week following, the parts should be douched daily with mild antiseptic and alkaline solutions, using an ordinary postnasal douche for the purpose.

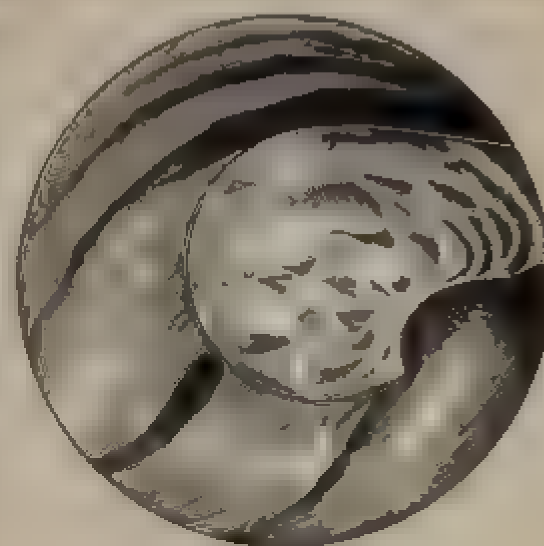

FIG. 54
Rhinoscopic Image of Snare in Position

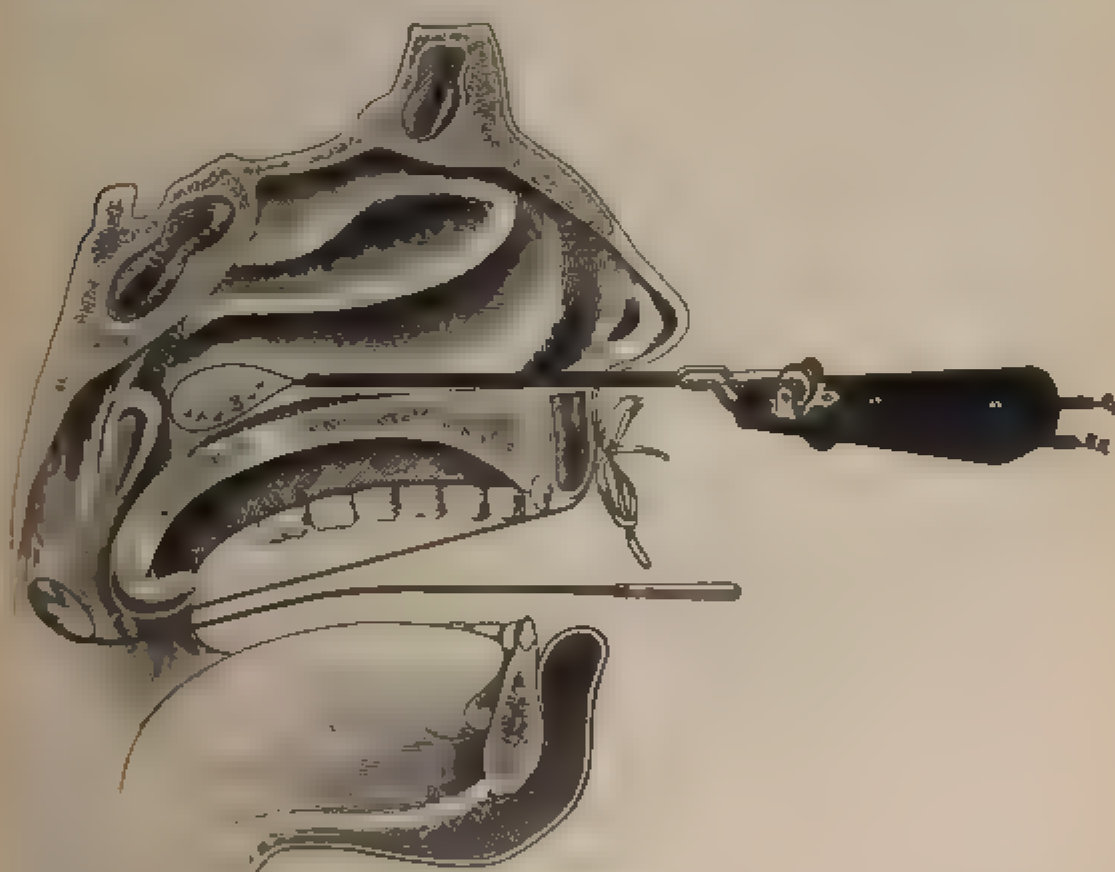

FIG. 54 (a)
Showing Method of Removing Posterior Hypertrophies by Means of the Electrocautery-Snare

121. The only contraindications to the employment of electrolysis or the electrocautery are such constitutional states

as usually militate against operative procedure. Anemic and hemophilic patients should be given the benefit of palliative treatment only, and the subjects of pulmonary or general tuberculosis may be exempt from all but the gentlest measures and those absolutely necessary.

ATROPHIC RHINITIS

122. Forms of Atrophic Rhinitis.—There has been considerable confusion in regard to the interpretation of terms defining this condition and closely allied states. Atrophic rhinitis has been made to cover ozena, simple atrophy, and the strumous type of the older writers. We shall throw aside the last term altogether and discuss only two forms of atrophic rhinitis, the *simple* and the *fetid*, or ozena. In order that one may correctly appreciate the character of treatment which these conditions call for, a glimpse at the pathology and morbid anatomy of these two states will be necessary.

123. Simple atrophic rhinitis presents a picture altogether opposed to that observed in the hypertrophic forms of inflammation. The affected structures, instead of taking on an increase of tissue-elements, exhibit rather a state of more or less permanent infiltration that shows no attempt at organization or absorption. The blood-vessels do not grow into the infiltrated layers, but the diapedesis from the normal vessels is extreme and the leucocytes pack the submucous and subepithelial spaces, coming to the surface in a state of partial necrosis. The cavities of the nose are not choked but tend rather to a roomy condition, which admits of abundance of air and favors the desiccation of the secretions. The glandular elements in the nasal mucosa are compressed and rendered functionless by the morbid process. The combination of these factors, that is, the desiccatory effect of free currents of air in respiration and the failure of the glands to lubricate the chambers of the nose, produces a dryness of the entire mucosa and the formation of crusts or scabs. These scabs are found usually in the deeper fossæ and recesses, and produce, by their irritating action, ulceration of the tissues beneath them. If

dislodged or separated, bleeding frequently results. The breath is tainted with odor to an appreciable extent. The constitutional state of the individual is usually impaired.

124. Methods of Procedure.—From the superficial glance we have taken of the conditions that confront us, it becomes apparent that all treatment must be aimed toward the removal of the crusts, the healing of the ulcers, the lubrication of the membranes, and the stimulation of the tissues toward a state of healthy activity. The outlook is not always encouraging. The first indication, the removal of the crusts, is best met by douching the parts with borax-solution, dilute hydrogen peroxid, or normal salt-solution. The more tenacious scabs may be brushed off by means of the cotton-wrapped probe. The ulcers are best dealt with by touching them with the flat blade of the electrocautery-knife in the manner hitherto described. The blade should be introduced cold and brought to a white heat at once and the floor of the ulcer lightly touched. The knife should be withdrawn cold. It is needless to add that the procedure should be effected under thorough illumination, either directly on ulcers situated anteriorly or indirectly by means of the rhinoscopic mirror if the ulcers occupy the posterior fossæ. Not more than two or, at most, three ulcers should be treated at a sitting, and an interval of 4 to 7 days should elapse before treatment is resumed. Alkaline and antiseptic douches should follow. The two indications last mentioned, namely, the lubrication of the mucosa and the stimulation of the tissues are best fulfilled by the judicious use of the mild constant current.

125. Treatment.—The application is as follows: Select a metal nasal electrode that is shaped something like a female catheter and attach it to the cathode terminal of the battery or source of current. Instead of a nasal electrode the operator may avail himself of an ordinary piece of copper wire well wrapped with absorbent cotton. This has the advantage in that it may be bent into any desired shape and serves the purpose equally as well, if not better, than the metallic conductors. The active electrode is made the cathode and is

introduced into the middle or lower fossa of one side of the nose, while the anode, or indifferent electrode, in the form of a moistened plate, is applied to the cheek or shoulder Commencing with no appreciable current the strength in milliamperes may be raised to 3 and continued for 10 minutes or until a rather copious watery discharge from the chamber is induced. The other chamber may be subjected to a similar manipulation at the same sitting or on the following day. Vibratory massage is a good adjuvant to the treatment Sittings may be held as often as three times a week for a considerable period. There is little or no reaction beyond a marked stimulation to secretion and a quickening of the arteriovenous circulation of the parts.

FIG. 55
Atrophic Rhinitis

Inflammatory reaction is not observed. Patient perseverance along the lines above indicated, coupled with attention to the patient's general health and surroundings, will undoubtedly bring about a decided amelioration of the condition if not an actual cure The operator is cautioned against the use of powerful stimulants of all kinds. The use of silver nitrate is contraindicated. The cautery should never be brought in contact with tissue not bearing an ulcer. Its use is seldom indicated and then only where there is actual loss of substance. Fig. 55 shows the usual sites of the scabs and the corresponding ulcers beneath. Faradism has been tried in atrophic rhinitis and has met with slight favor. Galvanism serves to a better purpose.

It is not to be forgotten that the nasal passages are very sensitive to stimuli of any character, and the patient may complain of certain reflex phenomena during the passage of the electric current. Sneezing is very common. Coughing may be very persistent and there is usually some lacrimation. Local pain and ringing in the ears and pain along various divisions of the fifth nerve are frequently observed.

FETID ATROPHIC RHINITIS, OR OZENA

126. Nature.—We are inclined to look on this condition as the expression of a trophoneurosis, a state characterized by anomalous nasal secretions. The precise etiological factor is not apparent, though we turn involuntarily toward constitutional states in seeking a cause, and certain it is that this affection most frequently occurs in young and debilitated subjects. Whatever may be the exciting cause its results supply the culture media upon which thrive the micro-organisms that give rise to the nauseating odor so characteristic of the affection. The malnutrition of the nasal mucosa, which is an invariable concomitant of the morbid process, ultimately leads to atrophy, especially of the turbinated bodies. The secretions, which are at first rather copious, somewhat ropy, and stinking, become scant and more viscid owing to the desiccating effects of the easily respired air and the alteration of the glandular structures. Crusts form, which ultimately lead to ulceration and hemorrhage. The patient seeks relief from the foul and intolerable odor which makes life a burden and necessitates almost complete seclusion.

127. Treatment.—Palliative measures, which consist in cleansing solutions, massage, and galvanism, may all be tried, but the condition demands more active therapeutic measures. While it is occasionally true that a young person will outgrow the affection, it more frequently happens that the affected individual bears throughout the greater part of his days the taint of the trouble, or else the hypertrophic form of inflammation brought on by recurring attacks due to the products of

ozena act as foreign bodies in the nasal cavities. The electrocautery has its place in the treatment of ulcers that appear upon the removal of the crusts. The method of application has already been referred to. The treatment, however, which has yielded the best result and is the plan of procedure par excellence is cupric cataphoresis, cupric electrolysis, or anodal cupric diffusion. It is well known that the anode is the disseminator of salts which are in relation with the electrode. Depending on this principle a copper electrode is made the anode, and a deposit of oxychlorid of copper is formed in the tissues. This deposit in some manner leads toward a stimulation of the structures, and aids in a restoration of a healthy state.

128. The method of application of cupric electrolysis may now be explained. Select two long, slender needles, one of

FIG. 56

pure copper and the other of iridoplatinum. Each is mounted in a needle-holder. The former is made the anode and the latter the cathode. Introduce resistance sufficient to bring the milliammeter to zero. The nasal passages are thoroughly cleansed with a mild, warm solution of borax (ʒ½ to O½) and all adhering crusts are wiped away. Any bleeding surfaces are to be touched with a $\frac{1}{1000}$ solution of adrenalin hydrochlorid. If the patient is a child, a general anesthetic is required, but for adults the application of a 6- to 10-per-cent solution of

cocain will render the operation painless. With the parts thoroughly illuminated the copper needle or anode is introduced into the tissues over the middle turbinate and passed along its entire length. It matters not if bone is encountered. The platinum needle *K* is similarly introduced into the tissues of the septum on the same side or along the nasal floor, as shown in Fig. 56. The current is now gradually increased until 10 to 15 milliamperes is passing. In spite of the fact that many operators use as high as 25 milliamperes, 15 milliamperes should not be exceeded. The duration of the sitting should not exceed 15 minutes. During the passage of the current the patient may complain of pains in the head and teeth, and at the same time, coughing, sneezing, lacrimation, and noises in the ears. These cease on opening the circuit. At the conclusion of the sitting it will occasionally be found that the copper needle is firmly adherent to the tissues. Reversal of the polarity for a moment will insure its easy withdrawal. Some patients will exhibit no reaction whatever following the electrolysis, while, again, others will now and then show a decided inflammation of an acute nature, which may not only affect the nasal passage of both sides, but extend to the neighboring sinuses. The trouble usually yields without further complications.

The results of electrolytic treatment are manifest in certain changes, which consist of a modification in secretion, the softening of crusts, and a marked diminution of the offensive odor. The secretions, which were thick, rather scanty, and odoriferous, become liquefied, the crusts become swollen and easily dislodged, and the breath of the patient becomes much less tainted. The electrolytic action is not wholly confined to one side of the nose, but is felt in the neighboring chamber as well. Almost every patient is decidedly benefited by one sitting. More than two electrolytic applications are seldom necessary. The after-treatment should consist in mild, warm, cleansing, and antiseptic douches, which the patient may be taught to administer to himself three times daily. It is fortunate that we have at our command a therapeutic agent that will yield such favorable results. The patient is willing and anxious to try any measure that will alleviate his pitiable state and make of a taciturn

recluse a useful member of society. It is scarcely necessary to state that only fresh, new needles should be used at each sitting.

TUBERCULAR RHINITIS

129. Nature.—Tubercular ulcerations in the nasal cavities demand early and thorough treatment. So long as any focus of disease lingers, even though the process be very benign in character, as is frequently the case where the disorder affects the mucous membranes, just so long will the patient run the risk of acquiring a general or a pulmonary complication. Radical removal of the diseased area is called for. It is important, however, not to confuse this condition with the syphilitic variety of ulceration, but the history of the case and the character and location of the ulcers will usually clear up any uncertainty.

130. Treatment.—General and tonic treatment is of prime importance. Good, fresh air and an out-of-door life should be insisted on. Cleanly habits in regard to the care of the nasal cavities are indispensable and the patient should familiarize himself with the use of the douches. The electrocautery affords the best results in the removal of the ulcerated areas. After a thorough cleansing of the chamber, a 10- to 20-per-cent. solution of cocain should be applied, followed by an application of adrenalin hydrochlorid $\frac{1}{1000}$. With the parts well illuminated through a speculum, the cautery-blade or cautery-loop of platinum is introduced cold and brought to a white heat as soon as it is brought near the ulcer. The tissues constituting the floor of the ulcer are to be thoroughly seared well down into the submucous structures. Allow the tip to cool and inspect the parts. It is well to bring the tip to a cherry heat and to touch again the cauterized area to assure the prevention of hemorrhage. Two or more small ulcers may be dealt with at a sitting, or one large one. Other foci may be handled at a subsequent time. An interval of a week should be allowed to pass before the second cauterization.

Following the operation there will be a rather sharp intumescence and inflammatory reaction, which, however, usually

subsides without causing trouble. Alkaline and antiseptic douches of mild strength are indicated daily. An oily spray tends to keep the irritated surfaces moist and protected.

HYPERESTHETIC RHINITIS

131. Nature.—It is beyond the province of a work of this kind to enter into anything like a complete discussion of the etiology and pathology of *hyperesthetic rhinitis*, or *hay-fever*, as it is most frequently called. The student will gain much from a perusal of the various articles in the text-books devoted to the subject. The history of the affection and the numerous experiments that have been made in the effort to substantiate various theories in regard to the causation should be familiar to every one. Probably no condition has given rise to greater speculation and interest, partly on account of its obscure nature and partly because of its widespread existence. The suffering of a patient with hay-fever will induce him to accept almost any effort in his behalf, and the fact that some have been benefited by a change of scene has contributed largely to the climatic treatment of the disease. It is well established that no one climate or altitude is adapted to all cases. A native of a reputed resort may even exchange locations with another sufferer. In all probability the radical change of surroundings which any travel affords is the active therapeutic agent. The reason for this is apparent when we consider the neurotic factor that doubtless enters into all cases. We cannot deny at the same time the potency of factors other than the neurotic, such as the peculiar idiosyncracies of individuals to different irritants and the local conditions of the nasal mucous membrane, which occasionally combine to defeat any plan of treatment other than a radical or operative one. Each factor deserves particular consideration at the hands of the specialist, but perhaps the most important one is the local condition of the nasal chambers. Many attacks of coryza, which simulate closely the onset of hay-fever, may be due to nasal spurs, rhinoliths, or some irregularity of such nature. Again, an area of hypertrophy may be a source of irritation that will render the individual responsive to

the slightest stimulus, such as a draft of air. Such facts should lead us always to a careful inspection of the respiratory passages. By this means alone are we able to differentiate accurately these similar conditions.

True hyperesthetic rhinitis may, and frequently does, exist without apparent lesion, but in such cases certain definite areas of hypersensitiveness to touch are always in evidence. These areas usually correspond to the tissues governed by the filaments of the ganglion of Meckel and the nasal branches of the ophthalmic nerves, and are situated on the middle and posterior portions of the middle and inferior turbinates, and in the anterior portion or vestibule of the nasal cavity. The touch of a probe is sufficient to arouse these sensitive spots, and intense itching, lacrimation, and sneezing, accompanied by congestion and increased secretion, are the results. Hysterical sneezing is a condition altogether different and may be relieved by this very procedure. The two states may, however, resemble each other strongly.

132. Treatment.—In the examination of a patient it is essential that the exact site of each of these hyperesthetic areas should be determined by actual inspection and touch. The existence of any irregularity should be sought for and remedied. When, however, the affection persists without apparent pathological conditions in the nose, we must conclude that the afferent nerves of the parts are oversensitive to stimuli and that this phenomenon must be the object of our attack.

We should endeavor to calm the nervous excitability, if possible, and the most efficient means of accomplishing this end is by the sedative action of the constant current. A metal electrode—an ordinary probe will serve—should be made the anode, and a current of 1 to 2 milliamperes should flow through the sensitive areas for a period of 1 minute. Several areas may be treated thus at a single sitting. The cathode is best applied to the cheek or outer aspect of the nose on the same side. The treatment should be given three times a week. Massage, vibratory or labile, with the wrapped electrode will serve as an adjuvant. The general health of the individual, his diet, sanitary surroundings, and general comfort must, of

course, be looked after where possible. He should be kept free from irritating atmospheres even at the expense of a temporary suspension of his labor or profession.

133. It must be admitted that all agents fail to alleviate in some instances. When every means, including internal medication with suprarenal extract and change of scene, has failed, it is well to resort to operative procedure with the electrocautery. The physician must know the location of the sensitive areas and designate two or three for operation. When the

FIG. 57

Designating the Areas Ordinarily Requiring Cauterization in Hyperesthetic Rhinitis

nasal chamber has been thoroughly cleansed and cocainized, the operator will select a platinum electrocautery loop or blade of small size and control the current in such a manner as to heat the loop instantly to a white heat. With the nares dilated and protected by a speculum the tip is introduced cold and brought near the area to be first treated. It is well to give preference to the anterior area so that a hyperesthesia there may not operate against posterior examinations and treatment. The loop is brought to a white heat, the designated spot lightly touched,

and the loop allowed to cool at once. All that is essential is to sear lightly the mucous membrane, thus destroying the nerve-terminations and obtunding sensibility. Two or three areas may be dealt with at a visit. There may be some reddening and increase in the watery secretion for a day following the cauterization, but the suffering is not increased, rather, the patient is relieved by the treatment. Two applications in a week are all that may be tolerated. All the areas should be touched before treatment is suspended and it may be necessary to sear some of them a second time. In Fig. 57, the usual sites for cauterization are indicated by the small circles. After-treatment is confined to thorough cleansing with warm salt-water and protecting the parts with an oily spray, which should be applied with an atomizer twice daily by the patient himself.

POSTNASAL CATARRH

134. A chronic inflammation of the posterior nares and the crypts about the vault of the pharynx will generally yield to routine measures. Proper hygienic conditions, tonic medication, the use of the postnasal douche, and insufflations and the correction of any irritating local cause will usually suffice to bring about permanent relief. A few cases, however, demand more summary dealing. It has been observed that in cases where the tissues remain persistently flabby and anemic, and where the discharges continue thick and purulent in spite of local medication, the light application of the electrocautery is very efficacious. A special cautery-tip is required, one that has the blade or loop shielded by a metal guard. Such an instrument is essential in order that the surrounding parts may be protected from the heat of the cautery. A tip such as just described, and known as *Sajous's tip*, is shown in Fig. 58. The method of application may be briefly outlined. The nasopharynx should be very carefully cleansed by means of the douche and any adhering patches of mucous or crust wiped

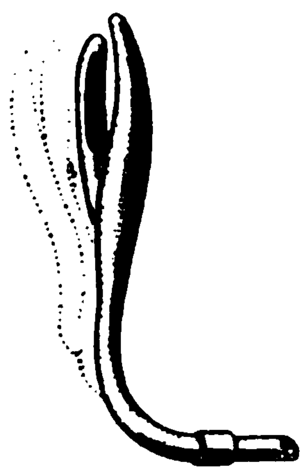

FIG. 58

Sajous's Cautery-Tip and Shield

away. The rhinoscopic mirror will show the areas to be treated and will permit of their direct cocainization. Introduce the cautery-tip cold and with the mirror still in position, bring the blade close to the area to be burnt. Now bring the tip quickly to a white heat and lightly sear the tissues forming one of the crypts (see Fig 59). The instrument is withdrawn

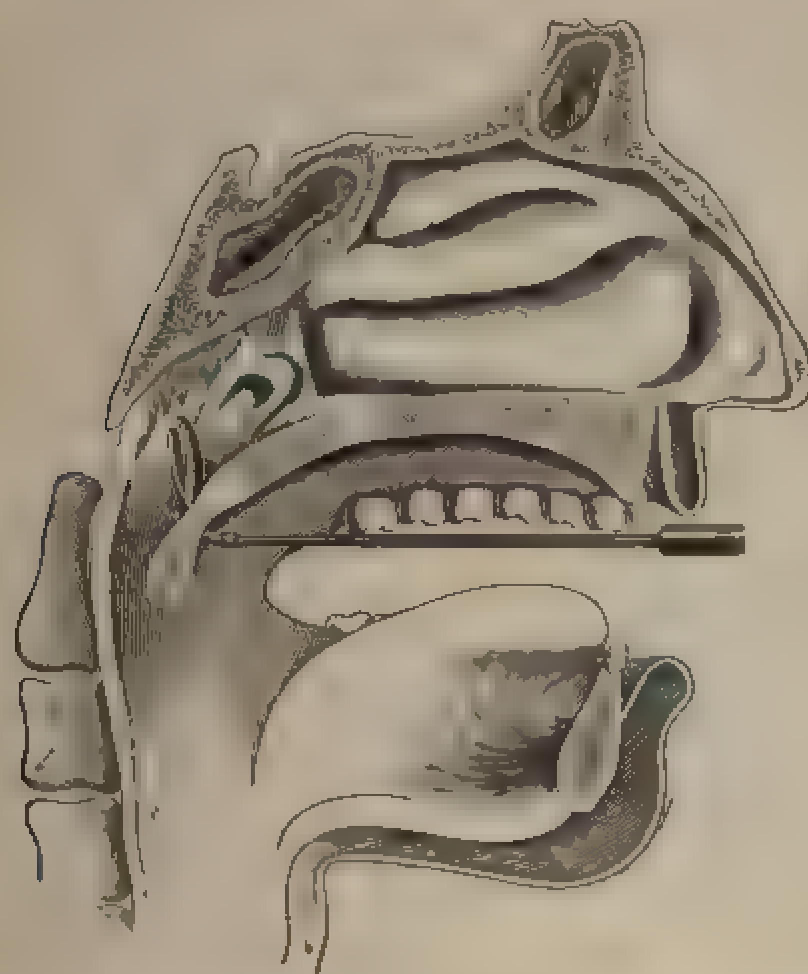

FIG. 59

Illustrating the Method of Applying the Electrocautery to the Nasopharynx

cold. Prior to cauterization, observe that the shield protects the surrounding parts. The reaction is very slight. The cauterization may be repeated biweekly until the secretions have become modified and the tissues take on a more normal and elastic appearance. Night and morning douches with warm saline- or borax-solutions constitute the after-treatment.

NEOPLASMS OF THE NOSE AND NASOPHARYNX

135. Malignant growths, such as cancer and sarcoma, of the nasal cavities, fortunately, are rare. Sarcomata frequently invade the nose by extension from the orbit and bones of the face, while carcinomata may originate in the epithelium of the nasal passages. The treatment of malignant growths consists in their free and early removal. The diagnosis is of prime importance, since if allowed to progress, the tumors soon invade territories difficult of access or entirely inaccessible to operation. The limited space in which we are obliged to work is a factor that leads us to abandon the knife and resort to either of two procedures—the electrocautery or electrolysis. The former is applicable in small growths, the latter in tumors of large size. The cautery-tip should be fashioned like a knife-blade and must be applied at a white heat, removing thoroughly all the infected tissues. The base of the growth is then to be carefully seared with the tip at a cherry heat, to prevent subsequent hemorrhage.

136. In malignant growths of a size too large to subject to cauterization, electrolysis will be found most serviceable. It matters little whether the growth be pedunculated, a rare condition, or sessile. A great temptation is afforded in either contingency to resort to the cold snare or the electrocautery-snare. Such procedure is scarcely to be recommended, for the reason that the growth is seldom, if ever, entirely removed, and recurrences are the rule. Electrolysis is performed in the usual manner, using the bipolar method. After thorough cleansing and cocainization, iridoplatinum needles, straight or curved, are introduced well beneath the base of the tumor, about $\frac{1}{4}$ inch apart. It is a matter of indifference which needle is made the anode and which the cathode. A current of 5 to 15 milliamperes is allowed to flow for 5 to 10 minutes. In small sarcomatous growths equal success will follow the unipolar method, making the anode the active electrode and applying the cathode to the cheek or shoulder. The current-strength and duration of the operation are about the same in each case. More than one sitting is usually required, and an interval of 4 days should elapse between the electrizations.

Thorough cleanliness and soothing douches should follow each operation.

137. In cases where malignant disease has reached a stage where radical measures are impracticable, or else declined by the patient, the operator has two resources still at his command. One is the employment of the mixed toxins of B. prodigeousus and B. erysipelatus, after the manner indicated by Coley. The cases benefited by this treatment are limited to sarcomata. The other resource is zinc electrolysis. Spherical electrodes of pure zinc are made the anode and brought in contact with the infected tissues. General anesthesia is necessary. The current-strength should not exceed 25 milliamperes. The effect of the galvanic current itself is augmented by the caustic action of the oxychlorid of zinc, which is diffused in the tissues during the process.

NASAL POLYPI

138. Nature.—Of the growths known as *nasal polypi*, we shall deal with both varieties, the myxoma, or mucous polyp, and the fibroma, or fibrous polyp. The points of difference pathologically between the two are of little practical importance to us beyond the indications for treatment that each suggests. The diagnosis requires no comment since these masses present slight resemblance as to appearance or location to growths of other nature. The manipulative skill required in the removal of polypi is considerable. The tumors are situated frequently in parts difficult of access, and unless one is skilled in the handling of postnasal affections the operations about to be suggested had better be referred to others. The surgeon is to be called in where the polyp is sessile and attached to the superior portions of the nasal cavity. Radical operations only are indicated in such cases and where the size of the mass renders ordinary procedure inadequate.

139. Treatment.—The means at our disposal in the treatment of polypi are, briefly, medicinal and surgical. The former consists in the application of astringents to produce a withering and contraction of the tumor, or the injection of drugs, such as carbolic acid, calculated to produce a similar effect. It

is serviceable only in polypi of a mucous type and is at best a palliative measure. The latter embraces the removal of the growth by means of evulsion, the cold snare, the electrocautery-snare, or electrolysis. Of these methods, the two last mentioned are the best.

Pedunculated polypi are treated in the following manner The nasal cavities are thoroughly cleansed and cocainized. With the parts thoroughly illuminated the electrocaustic irido-platinum snare is introduced cold and slipped over the mass and drawn well down toward the base of the pedicle. As soon

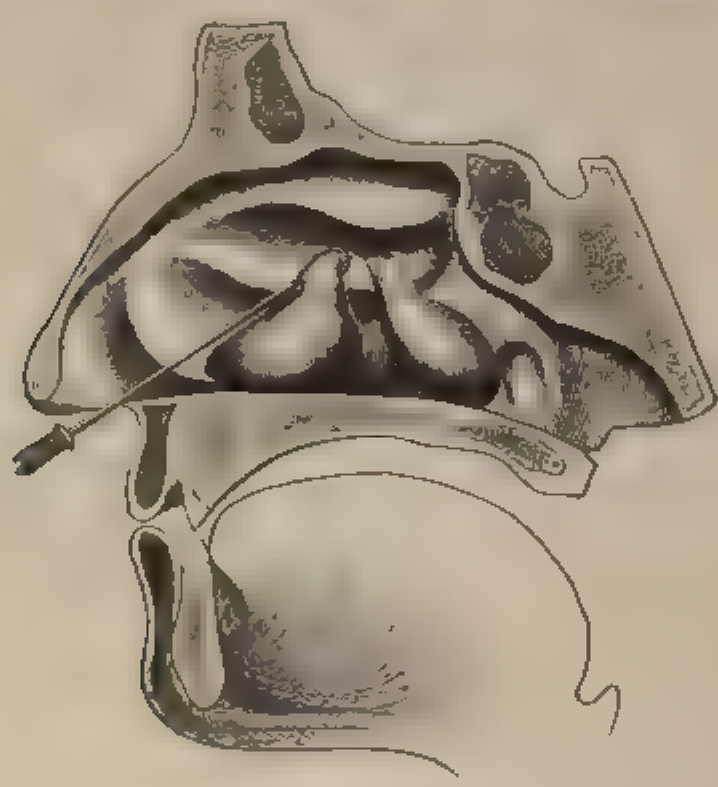

Fig. 60

as the loop is in position (see Fig. 60), the current is turned on for an instant to fix the snare in position. The circuit is now broken and the snare tightened a trifle. Alternate periods of glowing and tightening effect a safer removal of the tumor than instantaneous tightening or traction Scheppegrell's snare, having a rheostat in the handle that prevents fusion of the shortened loop, is a serviceable instrument for such work.

The cautery-snare may be employed in sessile growths, using Jarvis needles similarly to the method used in dealing with posterior hypertrophies. A plan equally advantageous, though

slower, is electrolysis, and this method is the operation of choice with many specialists, in fibrous polypi. The bipolar method is to be preferred, using long, lance-tipped, iridoplatinum needles, straight or curved, according to the position of the mass. Several sittings of 10 minutes each, with alternating periods of rest, are necessary. The strength of current need not surpass 25 milliamperes, though some operators have used as high as 90. If the electrocautery-snare is used in the ablation of growths that are sessile or have a broad peduncular attachment, it will be well to follow the method just mentioned, that is, of alternate glowing and tightening. By so doing one obviates the danger of hemorrhage and the necessity for subsequent cauterization of the base. If a polyp be removed by traction with a loop at white heat, it will be safer to sear the base with the electrocautery-tip at a cherry heat. The preliminary application of a solution of adrenalin hydrochlorid is a rational prophylactic measure. One need not work hurriedly. The length of time of an operation for the removal of polyp may be prolonged for an hour with entire safety and without inconvenience. It is much better to spend 1 hour in the operation itself rather than 2 hours at a later period in counteracting the results of hurry. Two or more small pedunculated growths or one large one may be removed at a single sitting. When electrolysis is used the sittings, of course, will of necessity cover a longer period. The after-treatment consists merely of meeting the indications that may arise. The complications that are possible seldom follow good technique and antiseptic routine. Mild cleansing and protective douches and sprays are generally sufficient. General tonic treatment is important.

DISEASES OF THE SEPTUM

140. The tissues covering the bony and cartilaginous portions of the septum are naturally susceptible to the affections that implicate the neighboring parts and are generally involved with them. The therapeutic measures directed toward the amelioration of all nasal affections apply equally well, as a general rule, to diseases of the septum. An exception is to be noted

in the case of the cautery. This instrument has a limited sphere and must be used with caution. The septum is so thin that perforation is prone to follow the use of any escharotic. The cautery is indicated in cases of hemorrhage from ulcers situated anteriorly, and in hemorrhage from this locality not attributable to disturbances of circulation other than local. The cautery-tip should be applied lightly, at a cherry heat, always under thorough illumination and through a speculum. Also, in thickenings over the part usually spoken of as the *tubercle* the cautery may find a place. Two or more light linear streaks may be made in the tissues with the platinum tip at cherry heat.

141. The agent that affords the most favorable results in the treatment of *septal spurs*, ecchondroses, and in *thickenings* that frequently accompany deviation of the septum, is electrolysis, and its utility deserves a wider recognition. Bipolar electrolysis is better adapted to these conditions than unipolar, since the latter is occasionally followed by perforation of the septum. The best results undoubtedly follow the use of iridoplatinum, copper, or zinc needles. These should be properly insulated so that tissues contiguous to the part to be treated need not undergo electrization. The needles are introduced $\frac{1}{8}$ to $\frac{1}{4}$ inch apart near the base of the spur or enlargement in a direction parallel to its long axis. If the mass be of large size, each electrode may consist of two or three needles mounted in the same handle like a hemorrhoid needle. Preliminary cleansing and cocainization are essential and adrenalin may be applied if bleeding is feared. Usually it is not necessary. A current of 5 to 15 milliamperes, gradually attained, should pass for a period of 10 minutes. Intervals of 4 days between sittings must be allowed always, and during this time the nasal passages must be kept thoroughly clean. The spur usually drops off after a fortnight. Bony spurs and exostoses are, of course, uninfluenced by the treatment.

142. Ulcers of the septum from causes other than specific are stimulated to healthy granulation by the use of cupric cataphoresis. A needle of copper may be introduced beneath

the floor of the ulcer, provided the lesion be superficial, or a bulbous tip of pure copper may be brought directly in contact with the ulcerated surface. The anode is the active electrode in either case, and the current-strength should gradually be augmented to 10 milliamperes. The sittings may be of 5 to 8 minutes in duration, and intervals of 3 days between visits should be allowed, during which time the parts must be kept clean and protected. When the entire floor of the ulcer bears a red appearance and shows healthy granulations everywhere, the active treatment should cease and the cleansing and protective agents employed until new epithelium covers over the defect.

EPISTAXIS

143. The etiology and treatment of nasal hemorrhage are so familiar as to require no comment. Of special utility, particularly in cases due to ulceration and in active arterial flow, is the electrocautery. The tip heated to a cherry red should be applied directly to the bleeding-point, never blindly. When recurrences follow, the ulcer is to be subjected to cupric electrolysis as previously indicated.

144. Faradism will be found serviceable in *anosmia* where the condition depends on hysteria or causes which do not interfere with the integrity of the olfactory terminations. The cathode is applied to the bridge of the nose or to the mucosa by means of a double metal electrode well covered by moist cotton. Faradism is useful also in *hysterical sneezing.* The sensitive spots on the mucous membrane are to be covered by a suitable electrode and a mild interrupted current allowed to flow for a short period of time.

Considerable interest has recently been aroused by the statements of the French specialists that dysmenorrhea may be relieved by treatment directed toward certain sensitive areas, called *uterine spots*, in the nasal mucous membrane. It is too early to form conclusions in regard to this claim, but if it be substantiated by future investigation, it cannot fail to be of interest to the specialist in rhinology.

DISEASES OF THE PHARYNX

ADENOID VEGETATIONS

145. Nature.—We have previously spoken of posterior nasal catarrh and indicated a rational plan of treatment. We now have to deal with a condition regarded by some as a sequel, and certain it is that pharyngeal adenoids may frequently enough be traced to preceding colds. The marked similarity of the lymphoid glandular structures in the pharynx to the tonsils renders them liable to processes similar to those which the latter undergo, and inspired Luschka to give them the name of pharyngeal tonsil. Glandular tissue is slow to resolve from an inflammatory affection and continued exacerbations lead on a chronic state accompanied by thickening and hypertrophy. Various dyscrasia may possibly influence the trouble to some extent, an observation which finds some confirmation in the fact that young persons in whom vitality is at a low ebb are most prone to the disorder. The symptoms are classic and its diagnosis easy. Direct inspection may give way to the diagnostic finger in children and the presence of the worm-like cushion is pathognomonic. Many writers urge the propriety of allowing the hypertrophy to exist unmolested until mature years have exercised a diminution in it. Such advise is scarcely to be adopted, since the presence of hypertrophies in the vault is a constant menace to hearing and the general health.

146. Treatment.—The treatment consists in the removal of the vegetations. This is successfully and easily accomplished by so many different plans of procedure that no specific statement can be made as to which plan is the best to adopt. One must rather be influenced by the demands of a particular case and avail himself of the one best suited. In children the growth may be scraped away by the aid of the finger-nail or by the pharyngeal curette. These maneuvers are wholly adequate. In older patients where the pharynx may be inspected with the aid of the mirror, we may resort to removal of adenoids with the cold snare, the electrocautery-snare, or the electrocautery. Whichever of these agents is made use of the operator must

bear in mind the relations of the structures in the pharynx, and avoid injury to the Eustachian orifice and other tissues. Where the tonsil is hard and well organized, the cold snare or the electrocautery will serve best. We are of the opinion that the electrocautery-snare should be reserved for cases where the growth is small and can be handled under direct inspection. Large adenoids may be reduced by the electrocautery, using a guarded tip, such as shown in Figs. 58 and 59. The method of using the various agents referred to, does not vary from general plans. If the galvanocautery-snare be used, the operator should practice the method of alternate periods of glowing, tightening, and rest, which has been previously alluded to. If the electrocautery be employed, it must be applied thoroughly under perfect illumination. The cold tip is brought close to the vegetation, and the parts to be seared touched in different places for practice. Note that the shield protects the surrounding structures. Rapidly bring the tip to a cherry heat and hold it firmly in contact with the mass for a second. Then move the tip slightly to a new portion and sear as before, reducing the entire vegetation in this manner before breaking the circuit and withdrawing the instrument cold. Preliminary cocainization is necessary. Hemorrhage seldom results. The application of a solution of adrenalin will check any oozing that may occur. No after-treatment is required beyond a mild antiseptic douche twice daily. Adenoid vegetations have been treated by the electrolytic current by certain operators, who claim that all adenoid tissue which can be reached by needles should be electrolyzed. While it is true that curved needles will reach the masses under discussion without difficulty, nevertheless, the cautery offers the more speedy and equally as thorough means of relief.

NASOPHARYNGEAL POLYPI

147. Nature.—Nasopharyngeal polypi are not common. The condition is, however, frequent enough to warrant a brief discussion. The polypi in this locality are invariably of the hard or fibrous type, taking origin from connective tissue either in the periosteum itself or structures covering it. They

give rise to symptoms that resemble an aggravated form of adenoid hypertrophy.

148. Treatment.—Total removal of the polyp is the only rational plan of treatment. The situation of the growth will determine in a measure the mode of attack. Some polypi are accessible to the electrolytic needle, and when this is the case the operator had best resort to it. If it be found that bipolar electrolysis is possible, the iridoplatinum needles, properly insulated, may be passed into the growth as near the base as possible, and a current of 5 to 15 milliamperes be permitted to flow for 10 minutes. Sittings may be held on every third day until the entire base of the polyp has been electrolyzed. If monopolar electrolysis alone is possible, the cathode should be made the active pole and the anode placed on the back of the neck. A current of 5 to 8 milliamperes is sufficient.

Where, for any reason, the operation by electrolysis is ill-advised, the physician may avail himself of the cold snare. The location of the tumor will determine to a large extent the choice of snares and the avenue of access. Some tumors may be reached through the nose alone, others through the mouth. The cautery-snare should never be used in localities where the Eustachian orifice is endangered, the cold snare then being preferred.

To adjust the snare to the polyp presents some difficulties, but it may be accomplished by working through both the nose and pharynx when it is impossible to grasp the polyp through either passage alone. Scheppegrell's snare is very serviceable. The mass should never be removed hurriedly or by traction. Periods of glowing and tightening and rest should alternate. As in the case of nasal tumors, 1 hour is none too long for such an operation. Where the cold snare is used, the base of the amputated mass may require a touch of the electrocautery at cherry heat. Treatment which is directed toward the reduction of polypi, by causing suppuration in the pharynx, cannot be too strongly condemned. The parts require no special attention following the operation. Cleansing solutions may be gently applied if desired.

MALIGNANT TUMORS OF THE PHARYNX

149. Malignant tumors of the pharynx may be treated by removal with the knife, écraseur, or electrolysis. The last is most applicable in hard growths. The snares are not to be relied on, because of the difficulty in removing all of the diseased tissue. Cupric or zinc electrolysis is recommended in advanced cases together with the treatment by toxins. The technique of electrolytic treatment does not differ from that in malignant disease elsewhere. The bipolar method is preferable.

ATROPHIC PHARYNGITIS

150. Nature.—*Dry sore throat* is a frequent companion of mature years, in which case it is an affection difficult to shake off. At an earlier period of life greater probabilities of a cure are vouchsafed but realized only after patient effort. The morbid anatomy, embracing the conditions of functionless, glandular structures, diminished vascular supply, and general tissue-atrophy, should prompt us to a rational plan of treatment.

151. Treatment.—The essentials of treatment consist in freeing the pharynx from adherent secretions, the lubrication of the parts, and the stimulation of the tissues to increased vascularity and greater functional activity. The first two of these indications may be met by appropriate sprays and douches. The solutions should contain ingredients that promote the solution or softening of dried secretion and favor the maintenance of a moist condition. Bicarbonate of soda and chlorate of potassium fulfil these requirements. The last-mentioned indication—the stimulation of the parts—is best met by the appropriate use of drugs, such as 10 to 15 grains of silver nitrate to 1 ounce of water, or a 50-per-cent. solution of iodin, or glycerin, or albolene, together with the applications of the galvanic current. Two metal electrodes, guarded by moist cotton, are introduced into the pharynx either through the mouth or one through the nose and the other through the mouth, and held in contact with the pharyngeal wall. A

current of 2 to 10 milliamperes is allowed to flow for 10 minutes. One electrode should be kept stationary, preferably the anode, and the other moved from place to place. It is not advisable to break the contact when shifting the electrode unless the current is first diminished. The galvanic treatment may be given daily. At the close of the sitting, inspection of the parts will usually show a vivid red color and an abundant secretion. Electrization by means of a long, curved electrode (cathode) submerged in water, which is held in the pharynx, has been recommended, but the tendency to swallow is usually so strong as to render the plan inadequate. As before mentioned, the results of treatment depend largely on the age of the patient. To afford relief alone, without the prospect of a cure, the treatment must, in old persons, be persistent. Patients young in life may be cured, but only after prolonged periods. It is scarcely necessary to add that the patient must accept all admonitions as to habits and adopt measures calculated to promote the general health.

FOLLICULAR PHARYNGITIS

152. Nature.—The name of *clergyman's sore throat*, which is sometimes given to this affection, suggests to us a factor in etiology that is abundantly substantiated by every-day experience. The overwork of the vocal apparatus together with its faulty use, perhaps, and the existence of a nasopharyngitis that bathes the parts in irritating secretions, are causes which excite the disease. The strain put on the glandular elements of the pharynx, in the effort to furnish lubrication sufficient to keep the speaker's resonance-chamber moist and smooth, manifests itself in an inflammation of the glands. The ducts become blocked and cheesy secretion accumulates, causing red, white-tipped elevations on the fauces and pharyngeal walls. The tissues become congested and the blood-vessels dilated. In some instances these little elevations or follicles burst and discharge their whitish contents, which cling to the mucous membrane in masses, but may be easily wiped away. Such a condition has given rise to the

use of the name *exudative* pharyngitis in distinction to *hypertrophic*, which latter is the same affection with unbroken follicles. There is little use for the preservation of these terms. The symptoms of this disease require no mention. In young and middle-aged persons the complaint may be cured. When it occurs in old subjects, an instance comparatively rare, the outlook for permanent relief is unfavorable.

153. Treatment.—The complete destruction of each inflamed follicle and the evacuation of its contents constitute the essentials of treatment. Of the various means of bringing these about but two of the best will receive mention—cathodal electrolysis and the electrocautery.

The throat is at first cleansed with a mild alkaline spray, and all adherent secretions are gently wiped away with a cotton swab. A special electrode carrying two iridoplatinum needles insulated to within $\frac{1}{4}$ inch of the tip is required. This instrument is made the cathode, and the anode is placed on the back of the neck. The needles are introduced deeply into the center of a follicle, and a current of 10 to 12 milliamperes is made to pass for 1 minute. A whitish, cheesy exudate appears at the site of puncture, which may be wiped away. This plan of treatment is most excellent, and its only inconvenience is the amount of time consumed.

154. A more speedy method of dealing with the follicles, and one equally as effective and painless, is by reducing each elevation with the electrocautery. An ordinary platinum loop twisted into a rope will serve for a tip most admirably. After the throat has been cleansed, the cautery-tip is brought to a cherry heat and plunged deeply into a follicle and immediately withdrawn. Half a dozen of the follicles may be punctured at a single sitting. The cautery not only destroys the follicle, but also removes and disposes of its contents. After the tiny operation each follicle looks whitish with a rosy areola of inflammation about it. The reaction amounts to nothing, and the patient speaks of a mild sore throat for a day or two. After an interval of 3 or 4 days the treatment may be continued until

all the little elevations have been destroyed. The pharynx should receive daily cleansing sprays of some alkaline solution and protective and lubricating sprays of oil. New crops of enlarged follicles call for puncture with the cautery. The relief afforded by this treatment is very great. Hygienic and constitutional treatment should never be neglected.

PHARYNGEAL ABSCESS

155. Pharyngeal abscess may be incised by means of the electrocautery with far greater safety and better results than with the bistoury. A tip consisting of a platinum blade may be used. The abscess should be incised near its most dependent part to facilitate drainage. The incision should be of extent sufficient to warrant its remaining patent. If the quantity of pus is large, preliminary aspiration is recommended.

PHARYNGOMYCOSIS

156. In the rare instances where the leptothrix fungus finds lodgment in the pharynx, very radical measures are called to eradicate it. The various foci of growth require to be destroyed by the electrocautery under cocain anesthesia. Even this drastic measure sometimes fails, in which cases cupric electrolysis should be afforded a trial. The diffusion of cupric oxychlorid that accompanies anodal electrolysis is fatal to the life of the fungus.

PARALYSIS OF THE PHARYNX AND SOFT PALATE

157. Nature.—Muscular paralyses of the throat may be due either to central nervous disease or may constitute a factor of systemic disease. On the etiology depends the prognosis to a large extent. Diphtheritic and allied palsies are wont to recover entirely, while paralyses dependent on central disease seldom, if ever, entirely recover. The character of the palsy, whether spastic or atrophic, depends on which neuron is involved, and

may be determined readily by subjecting the muscles to faradic stimulation. A muscle undergoing atrophy will not respond, while a muscle governed by a healthy upper neuron will react to the stimulus. Much improvement may be looked for in the latter condition, particularly if the process be part of a hemiplegia, but in the former no treatment is of avail.

158. Treatment.—Treatment consists in stimulating the muscles by means of cathodal electrization with the constant current. The active electrode may consist of a metal plate or sound well wrapped in moist absorbent cotton. This electrode is brought directly in contact with the tissues, while the anode is placed on the back of the neck. Mild currents are best. Interruptions of the current are occasionally serviceable. The therapeutic measures recommended in the treatment of atrophic pharyngitis are applicable to this condition also. Where the velum palati is involved in the palsy the cathode may be immersed in water held in the throat. In diphtheritic and syphilitic paralyses the constitutional treatment should be of prime importance. In nuclear palsies affecting single muscles or a group of them, treatment is of no avail whatever, and measures that tax the strength of the patient are not to be commended.

HYPERTROPHY AND ELONGATION OF THE UVULA

159. In cases of moderate elongation of the uvula giving rise to cough and pharyngeal irritation, the application of the electrocautery, at a cherry heat, to the posterior surface will produce a contraction of the organ sufficient to allay the symptoms. Where the hypertrophy and elongation are extensive, cauterization must give way to amputation. Cocainization is advised. The tip of the uvula should be caught with forceps and drawn forward before the cautery is applied, so as to check the elevation of the uvula and to avoid injury to the surrounding tissues. Simultaneous injury to the posterior surface of the uvula and the posterior wall of the pharynx may result in synechia.

DISEASES OF THE TONSILS

HYPERTROPHY

160. Nature.—Pathologically considered, the faucial adenoids resemble the pharyngeal tonsil referred to previously. The tendency of lymphoid tissue to undergo hypertrophy and take on a growth of fibrous tissue is well known. This process is called organization, and up to a certain limit appears to increase with age. In children, the hypertrophied tonsils are seldom hard, while in young adults the hardness, which may be taken as a degree of organization, is at its height. In mature years and old age the tonsils tend toward absorption, a fact which accounts for the cases of "outliving the trouble." Were it not for the systemic disturbance that these adenoids create, and the complications that follow, the masses might be left to undergo spontaneous absorption with age, but the existence of a constant menace to health should not be tolerated, since the battle is too frequently won at the expense of constitution. The morbid anatomy and symptoms of the affection are too familiar to excite comment. The indication that confronts us is met by the removal of the hypertrophied masses, together with due attention to the general health and hygienic surroundings of the patient. A rheumatic diathesis may be suspected, and the family history may throw some light on this problem.

161. Treatment.—We have a strong conviction that the details of the operation for the removal of enlarged tonsils should differ radically according to the age of the patient. In children, the masses are generally soft, although they may attain enormous size. Where this absence of induration exists we possess a reasonable assurance that organization has not progressed to a marked degree. These soft adenoids are best removed by means of the tonsillotome or guillotine. The hemorrhage following is very slight and the mouths of the severed blood-vessels quickly contract and close. The operation itself is speedy and almost painless. The condition is changed, however, in young adults. Here we have a quantity of fibrous tissue, which supports the blood-vessels and tends to keep them open when severed. The

masses feel hard and resilient to the touch. It is by no means claimed that the removal of hypertrophied tonsils in young adults is always followed by hemorrhage. Indeed, this complication is rare. The tendency toward hemorrhage, however, is invariably present, and sooner or later the operator will have his turn in the treatment of the complication. An experience with sharp bleeding after the removal of adenoids with the knife or guillotine in young adults will prove conducive toward caution and will not be easily forgotten. The safest plan of procedure is the ablation of the masses by means of the electrocautery-snare. To be sure, the operation requires a longer time than the guillotine, but the tendency to hemorrhage is vastly diminished. The parts are thoroughly cleansed and a 10-per-cent. solution of cocain applied. If the tonsil is hidden by the pillars to an extent that interferes with its being readily grasped by the snare, it should be transfixed by a needle and brought into the field by light traction. The snare should be manipulated with a view to alternate intervals of glowing, tightening, and rest. The electrotonsillotome is operated on a similar principle. The method of treatment by electrocautery puncture is painful and leaves unsightly results, and that of cautery dissection is so slow and painful as to warrant its abandonment.

162. Electrolysis finds a place in the treatment of adenoids where the lymphoid tissue presents the characteristics of diseased structure rather than mere hypertrophy. In malignant disease, also, this therapeutic agent is indicated. Bipolar electrolysis is preferable, using long and properly insulated needles of iridoplatinum. Where the growth has progressed beyond a condition where entire removal is possible, the specialist should resort to copper or zinc electrolysis. The electrolytic needles, suitably mounted in a carrier, are introduced into the tonsil near its base and carried on until the point slightly protrudes on the posterior aspect, using a tenaculum or forceps to draw out and steady the mass. It is well to begin near the inferior border and progress toward the superior aspect at subsequent electrizations. A current of 12 to 20 milliamperes may be utilized for 10 minutes

at all sittings, which should occur not oftener than 4 or 5 days apart. The reaction following all operative measures on the tonsils is slight and occasions no trouble usually beyond a slight inconvenience and soreness.

CHRONIC FOLLICULAR TONSILLITIS

163. Chronic follicular tonsillitis, characterized by the enlarged tonsils with their lacunæ filled with white cheesy exudate, the foul breath, cough, the proclivity to recurrent exacerbations of acute sore throat, etc., demands for relief the destruction of the follicles together with the removal of the contents. Analogous to the follicular inflammation of the pharynx in so far as the indications for treatment are concerned, the tonsillar affection affords a striking illustration of the utility of the electrocautery. A platinum tip of a pattern similar to that recommended in Art. **153**, only longer and somewhat thicker, is required. The glowing tip is to be depressed to the bottom of each follicle in turn until half a dozen have been cauterized. The cauterizations may be continued at a subsequent visit some few days later. At the completion of the treatment the disease is cured. Local antiseptic and soothing sprays form a good adjunct to the treatment.

LINGUAL ADENOIDS OR HYPERTROPHY OF THE LINGUAL TONSIL

164. The pathology of this condition is precisely similar to that of an enlarged faucial and pharyngeal tonsil. In making an examination of the throats of young persons the physician should invariably carry his finger to the base of the tongue and behind the soft palate whenever there are indications of faucial adenoids. The reduction of the lingual hypertrophies is best accomplished by applications of the electrocautery at glowing heat under direct inspection so as to avoid injury to the epiglottis. Snares are not to be recommended, and bipolar electrolysis is employed only when the mass is very hard and of large size.

STENOSIS OF THE EUSTACHIAN CANAL

165. Although affections of the Eustachian tube properly fall under the division of diseases of the ear, nevertheless, the subject of the treatment of strictures of this organ is here given for the sake of convenience and because the avenue of access for the exhibition of local measures is approached through the nose and pharynx.

In nearly every case of chronic catarrhal otitis media, the tube is blocked early in its progress. It is brought about simply by an extension of the affection from the middle ear. The term chronic tubal catarrh, under which this process is described, represents an extension then of the inflammation to the Eustachian tube and nothing more. If we inquire into the nature of the pathological anatomy in each location, we will find the changes to be the same. Hyperemia, exudation, and infiltration, followed by more or less organization and submucous hypertrophy, are the features common to both. It cannot be gainsaid that the affection may be confined to one or the other organ alone. When it exists in the tube, whether the tympanum be implicated or not, the result is deafness, and the deafness is functional or not, depending on the integrity or involvement of the middle ear. If occlusion of the tube exists alone, the functional deafness will be remedied by rendering the canal once more patent. The importance of relieving an obstruction of the tube is realized when we are taught that stenosis is one of the prime causes of middle-ear disease when that organ is not yet affected, and the cause also of still further trouble if disease already exists.

166. Let us now suppose that we have a stricture of the tube, which is due to exudation and infiltration, i. e., organized. By what plan of treatment may we obtain the most efficient and lasting effects? Electrolysis fulfils these requirements to a degree better than any other agent that we possess.

The method recommended is that of Bordier, which may be briefly outlined. The specialist should be provided with a graduated set of copper bougies ranging from 3 to 6 of the French scale, mounted on No. 5 or No. 6 copper wire. These

are so fashioned as to fit into ordinary silver Eustachian catheters, which are insulated from tip to mouth. The bougie is to be pushed full length into the catheter until its copper tip protrudes slightly in the opening (*a*), Fig. 61. The catheter

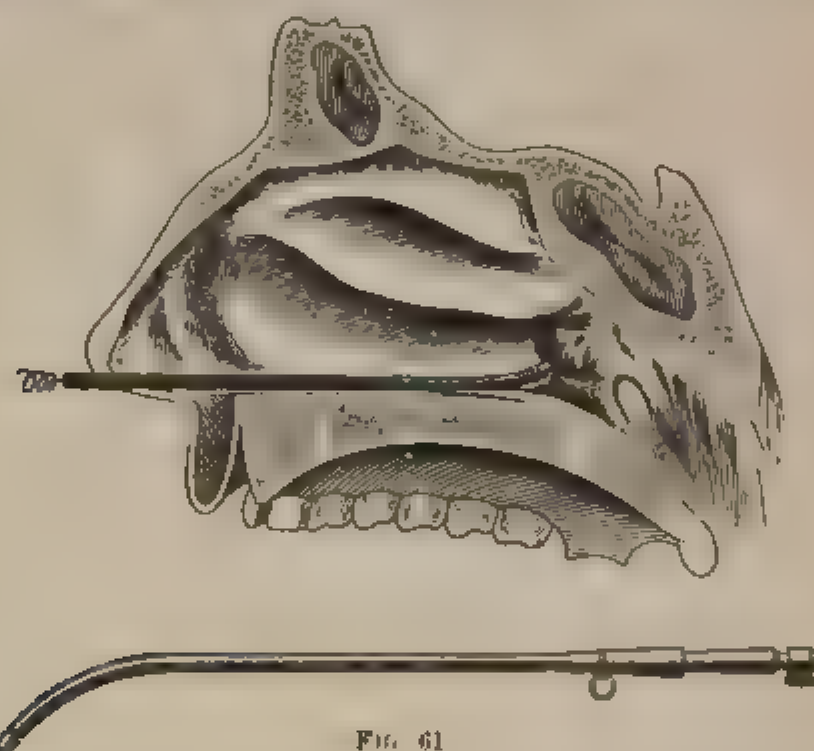

FIG. 61

is now introduced into the tube in the usual manner and carried along until the tip meets the obstruction, Figs. 61 and 62. The wire is then attached to the cathode terminal of the current source and from 2 to 5 milliamperes is passed for 2 to 5 minutes. The operator will now observe that the bougie passes on with greater ease. More of it, therefore, is pushed in and the same quantity of current is administered for 5 minutes. At the end of this time the catheter and bougie are withdrawn together. Duel uses bougies of gold of a length sufficient to allow protrusion for 1½ inches or more beyond the tip of the catheter. This arrangement permits the electrization of the entire canal at once. Better results are gained by the employment of weak currents for a longer period of time than by using strong currents for a brief sitting. It is understood, of course, that electrolysis alone does not constitute the entire treatment. Routine measures with insufflations, etc. are to be carried out

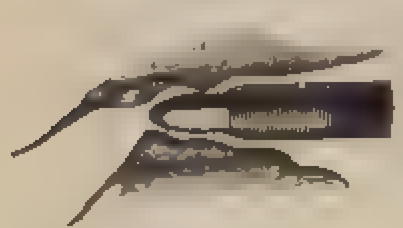

FIG. 62

concomitantly. The sittings should be repeated as often as twice weekly, using a bougie of larger caliber on each occasion, if possible. Daily catheterization and insufflations are advised during the intervals. The middle ear should receive proper attention. Even if it be impossible to restore hearing by the reduction of the stricture, the tinnitus which is so commonly present and so persistent is very frequently entirely dispelled.

DISEASES OF THE LARYNX

167. The diseases of the larynx that are amenable to electrical treatment are not numerous, but they require the highest degree of manipulative skill on the part of the operator. It is imperative that he should be perfectly familiar with laryngoscopy (see Fig. 63), with the method of making applications to the interior of the organ, and accustomed to the use of laryngeal instruments. The area in which one must work is very small, and whatever operation is done it must be performed under full illumination and inspection. The cautery finds a limited application in this field. Its use is prone to occasion edema or to be followed by cicatricial contraction, a sequel which entails serious consequences if it occurs about the ary-epiglottic folds or the interarytenoid space. The indications for the use of this instrument will be mentioned later. Electrolysis is serviceable and may be used on any tissue of the larynx that can be reached by properly insulated needles. Of late years,

FIG. 63

Showing Position of the Laryngoscopic Mirror

cataphoresis has taken a high therapeutic position. Its use is commended, and it is hoped that it will find a more general reception. Faradism is useful in certain motor affections of the larynx and as a stimulant to the tissues following treatment for tumors, syphilis, etc.

TUBERCULOSIS

168. While this condition, generally, is secondary to foci of infection elsewhere, as for instance in the lungs, the fact remains that not infrequently the laryngeal focus is the primary one. It is of the utmost importance, therefore, that an early diagnosis be made and appropriate treatment instituted at once. Cupric cataphoresis as suggested by Doctor Scheppegrell, of New Orleans, is the method of treatment that offers the greatest encouragement. It possesses advantages over the cautery, the curette, and electrolysis, in that there is no inflammatory reaction, no secondary bleeding, and no wounding of the tissues, thereby to open up fresh avenues for infection. An exception is taken in the case of very hard diffused masses of infiltration in and about the ventricular bands. These yield best to unipolar cathodal electrolysis with a current of 10 milliamperes for 5 minutes at a sitting. Their position renders them tolerably easy of access.

In the treatment by anodal electrolysis, laryngeal bougies tipped with pure copper are used. The larynx is first cleansed and then anesthetized with a 10-per-cent. solution of cocain. The indifferent cathode is placed on the back of the neck. The bougie, which is made the anode, is introduced into the larynx by the aid of the lamp and mirror and brought in contact with the diseased area. A current of 0 to 5 milliamperes, gradually attained, is allowed to flow for 1 to 2 minutes. The treatment may be continued after a day of rest. Hygienic and systemic treatment should be carried out faithfully.

TUMORS OF THE LARYNX

169. It is fortunate that the benign tumors of the larynx are by far the most common. The various species of papillomata are most frequently seen, and the angiomata, myxomata,

and cysts less often. Malignant disease, when it makes its appearance in this organ, calls for the most radical of measures, and complete excision offers the only hope in many instances. It will be difficult to lay down hard-and-fast rules for the

FIG. 64
Laryngeal Cautery-Tips and Snares

management of the various laryngeal growths. We will therefore deal generally with the subject, and the student will do well to consult his own experience and judgment in a given case.

170. Treatment. Cysts and the softer neoplasms, embracing the soft warty or mulberry papillomata and sessile

FIG. 65
Electrocautery Tips and Handles for Laryngeal Work

fibromata may be successfully treated by the electrocautery-tip or snare. The dangers attending the use of this instrument

have been alluded to and should never be underestimated. The most careful manipulation is required. The cautery must be in perfect working order, and the current-controllers and circuit openers and closers must work quickly and smoothly. The apparatus is to be so controlled as to bring the tip instantly to a cherry heat. Some of the laryngeal cauteries in more common use are shown in Figs. 64 and 65. The use of the cautery in

FIG. 66
Showing Position of Mirror and Cautery in Laryngeal Work

the larynx should practically be limited to this class of cases and one other, viz., the treatment of the bases of tumors that have been otherwise removed.

The patient is seated in front of the operator in the laryngoscopic position Under perfect illumination, the larynx is inspected and cocainized. With the mirror still in position, the curved laryngeal electrode bearing the cautery-tip is passed cold

into the glottis and held for a moment in contact with the growth (see Fig. 66). The operator then slightly carries the tip away from the tumor, closes the circuit, and touches the part to be cauterized once, twice, or three times, lightly and quickly. The circuit is then broken and the instruments withdrawn. Soothing insufflations and protective sprays are indicated following this procedure. There is scarcely any pain, but there may be a marked inflammatory reaction calling for ice-applications and sedatives. An interval of a week should elapse before further operations of this character may be allowed.

171. The hard fibromata, tumors with broad, sessile bases, and malignant growths in their early stages may be treated by electrolysis, provided the growth is accessible to electrolytic needles. Bipolar electrolysis is best, the two short and thoroughly insulated needles of iridoplatinum being attached to a curved laryngeal electrode. The needles are introduced into the tissues near the base of the tumor under full illumination and inspection. A current of 0 to 5 milliamperes, gradually attained, is to be used for 5 minutes or as long as the patient's subjective sense and strength will permit. Weak currents applied for longer intervals of time are not so apt to incite unfavorable reactions as strong currents given for brief periods. Intervals of 4 days should elapse between electrizations.

172. Malignant tumors of the larynx, where for any reason a radical operation is refused and the growth has progressed beyond the aid of ordinary measures, may be treated

FIG. 67

Copper- or Zinc-Tipped Laryngeal Electrode

by cupric or zinc electrolysis, using an insulated electrode tipped with a ball of pure copper or zinc, Fig. 67. This electrode is made the anode, and the cathode or indifferent electrode is applied to the back of the neck or shoulder. The instrument is introduced into the larynx under full illumination with the mirror, and brought into contact with the diseased tissue.

The current should be gradually raised from 0 to 5 milliamperes and the length of the time of the sitting should not exceed 2 minutes. The reaction is very slight and the sittings may be held as often as every second or third day. In growths of a sarcomatous character that have surpassed local bounds and become inoperable, the toxins of Coley should be afforded a trial in conjunction with the treatment just referred to. General tonic measures and attention to the patient's comfort and hygienic surroundings are essential in the management of this class of patients.

STENOSIS OF THE LARYNX

173. It will be unnecessary for us to inquire particularly into the causation of laryngeal stricture, since these factors are so well known. Of greater importance to us are the consequences and the management of the cases. Any degree of stenosis leads to a serious alteration of function, and a considerable narrowing necessitates the creation of an artificial channel for respiration. As in stenosis elsewhere, as we have seen, electrolysis offers the best means of alleviation. Those cases, particularly, in which a cannula is worn in a tracheotomy fistula offer the most gratifying results. An instance is recorded of a complete cure, so far as respiratory function is concerned, in a man who had worn a cannula for 16 years.

174. Treatment.—We may divide the cases of stricture into two categories, those in which a tracheotomy is required and those in which it is unnecessary. In the former class the treatment is simple enough, but in the latter we meet with some perplexing questions. Let us suppose a case of narrowing, in an adult, in which there is developing a submucous hypertrophy and organization, and where the anteroposterior diameter is only 6 or 7 millimeters. In such a case, cathodal electrolysis with an O'Dwyer intubation-tube of copper would offer good prospects of cure without tracheotomy. An intubation-tube adapted to a child 4 years old should be selected. Where, however, the anteroposterior diameter of the larynx is less than 7 millimeters, a tracheotomy preliminary to treatment is advised. For cases wherein tracheotomy is unnecessary,

the operator may make use of copper intubation-cannulæ for electrodes, and where the patient requires tracheotomy or already wears a cannula, a graduated set of laryngeal copper bougies is required.

175. The method is quite similar to that of the electrolysis of strictures elsewhere. Under illumination and inspection the tube or bougie is introduced into the larynx and is made the cathode. The anode is placed on the back of the neck. A current of 5 to 20 milliamperes should be passed through the tissues for 5 minutes. Two days should intervene between sittings. When the caliber of the larynx has attained a size that assures the permanency of the respiratory function, the treatment may be suspended and the tracheotomy fistula, if one exists, closed.

MOTOR AFFECTIONS OF THE LARYNX

176. Motor affections of the larynx are benefited by direct stimulation of the muscles by the interrupted current, using the cathode as the active electrode. The same treatment

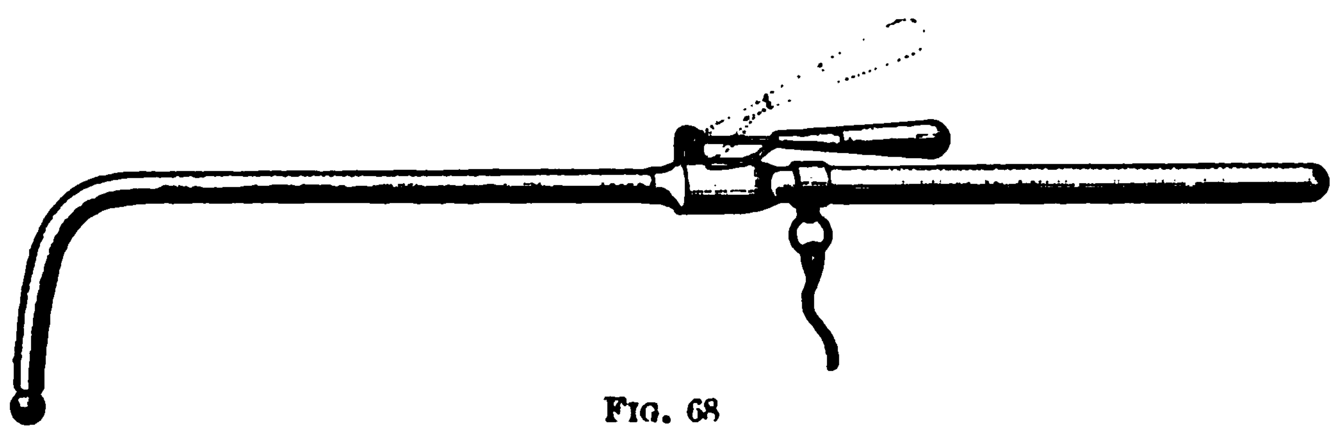

FIG. 68

McKenzie's Laryngeal Electrode

is beneficial following, or as an adjunct to, the treatment of neoplasms, tuberculosis, syphilis, etc. The instrument best adapted for this purpose is McKenzie's electrode, Fig. 68, or some modification of it, as in Fig. 69. The electrode is introduced into the cocainized larynx by the aid of the laryngoscope and brought as closely as possible in contact with the muscles. The strength of current and duration of application must be governed by the patient's subjective senses. Daily sittings are not too frequent. The anode is placed externally over the thyroid cartilage. Methods that are inferior to this, but which may be utilized when, for any reason, it is unavailable,

consist in the external electrization with the interrupted current, placing an electrode on either side of the larynx; or electric

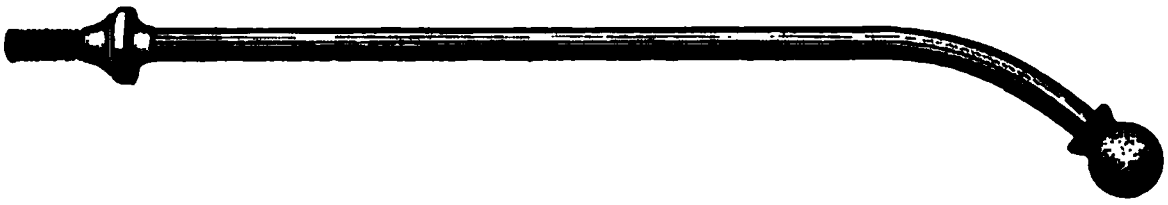

FIG. 69
Modified McKenzie Electrode

massage, making the hand of the operator the active electrode.

NEUROSES AND FUNCTIONAL VOCAL PALSIES OF THE LARYNX

177. Galvanism has received the sanction of many authors in the treatment of neuroses and functional vocal palsies of the larynx, using monopolar or bipolar direct internal or indirect external applications. Of greater value, however, is the interrupted current as used in Art. **176.**

In speakers and singers, galvanism may be useful to stimulate the motor nerves of the larynx, placing the cathode over the posterior border of the thyroid cartilage at the point of entrance of the recurrent laryngeal and the anode at the crico-thyroid articulation. Persons who use their voice to a great extent frequently manifest a hoarseness that would seem to indicate a laryngitis, did not the laryngoscope prove the contrary. It is in such cases that galvanism proves serviceable and should be afforded a trial.

HYSTERICAL APHONIA

178. As an adjuvant to the proper general management of such cases, faradization of the larynx either by direct internal or external methods is serviceable. Galvanism, using rather strong currents with frequent interruptions, or the static spark, may be used instead of faradism. It is claimed by some that the timbre and strength of the voice are aided by the inhalation of ozone generated by the sparks of the static machine or induction-coil. In some healthy individuals ozone is a decided irritant to the larynx and its use should be attended with caution.

ELECTRICITY IN GENITO-URINARY DISEASES

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INTRODUCTION

1. Electricity is the most wonderful force in nature. The progress made within the past few years in utilizing it has been so rapid and effective as to be little short of marvelous. The most recent example of its perfected use was in the lighting of the Pan-American Exposition with a current generated at Niagara Falls. Here was shown such perfect control of a current of prodigious power that there was seen simultaneously in many hundred thousand lamps many shades from but a faint beam of light to the full brightness of the incandescent lamp, likening the effect to the ponderous trip-hammer with power to crush the huge boulder, and yet capable of such fine adjustment as to merely crack the shell of a robin's egg.

It is conceded that there is only one kind of electricity, but its actions vary widely, according to the current and instruments employed in utilizing it. This agent manifests various properties, as attractions and repulsions, chemical decompositions, luminous and heating effects, and many other phenomena. Unlike gravity, it is not inherent in bodies but is excited or induced in them by a variety of causes.

2. But the purpose of this section is to show what electricity accomplishes as a remedial agent in genito-urinary diseases. As great as has been the progress in utilizing this agent in the

other arts, even more wonderful has been the success attending its application in the healing art, and some maladies are now cured by electricity that were formerly not amenable to any medicinal treatment. Its rise in medicine was received a generation ago with much promise of success, but owing to insufficient knowledge and crude apparatus it again fell into disuse. The great majority of physicians discarded it or allowed it to languish in comparative obscurity until the small band of faithful students and investigators had by ceaseless toil overcome difficulties, which now makes it stand forth in a light of success that seems destined to grow brighter and brighter as the days, months, and years beat funeral marches to the grave for less efficient remedies that must now give way forever to electrotherapy.

CURRENTS OF ELECTRICITY

3. The general electrician considers practically only two currents—the *direct* and the *alternating.* But in electrotherapeutics more subdivisions are made according to the voltage, amperage, and quality of current required to meet different indications in disease. The currents used in medical practice are also of two types—direct and alternating—but a distinction is made according to the apparatus from which they are derived. The first may have its source in a primary battery, storage-battery, direct-current dynamo, or static machine. The second type is derived from the physicians' induction-coil, a sinusoidal apparatus, alternating-current dynamo, or a static machine, when a spark-gap is introduced in the circuit.

DIVISION OF APPARATUS AND CURRENT

4. The following classification represents the currents used in the diseases under consideration:

Galvanic Current.—This is derived from chemical cells, storage-batteries, dynamos, and from the commercial circuit.

Faradic Current.—This is an alternating and interrupted current, sometimes called electromagnetic, secondary, or induced current, and is derived from the physicians' induction-coil.

Sinusoidal Current.—This is an alternating induced current without interruptions, and is derived from the sinusoidal apparatus.

Static Electricity.—Frictional electricity, also called Franklinism, or static electricity, is derived from static machines improved by Wimshurst, Toepler, Holtz, and Morton.

A knowledge of physics is necessary to a proper understanding of the principles of these currents, but this cannot be considered in this work, and the student is referred to the first four Sections of this Course.

ARMAMENTARIUM FOR GENERAL PRACTITIONERS

5. General practitioners object frequently to the expense for the apparatus required in the application of electric currents. This would indeed be a serious obstacle if the extensive apparatus used by the specialist were required for effective work. Fortunately this is not the case, as less expensive apparatus may be obtained that will give satisfactory results even in the hands of a beginner. For this reason, we outline below the necessary expense for apparatus from which the general practitioner may expect satisfactory results.

One 20- or 24-cell galvanic battery, pole-changer, and current-controller	$ 30.00
One high-tension coil faradic battery with total length of coil 4,500 to 8,000 feet . . .	50.00
One milliammeter	23.00
Electrodes, conducting-cords, handles, etc. .	20.00
Total	$123.00

This gives the cost, approximately, for good instruments of any reliable maker. From the list we have purposely omitted the old family faradic battery and other cheap apparatus as useless. They have already done much to bring electrotherapeutics into disrepute.

A reliable outfit for illumination and electrocautery-work with the necessary accessories may be added when required at

an additional cost. The armamentarium required for more extended work for the specialist will comprise:

One 20- to 24-cell portable galvanic battery .	$ 30.00
One high-tension coil faradic battery . . .	50.00
One cabinet galvanic battery, stationary . .	150.00
One milliammeter	30.00
Electrodes, in large variety	40.00
One storage-battery	50.00
Total	$350.00

6. The specialist's armamentarium will not be complete unless he adds a good static machine, cystoscope, endoscope, and different electrodes, and possibly a portable electrocautery-apparatus, for operations at a distance from home. Other additions may be made, until $1,000 has been easily spent. We have fitted up two offices at a cost of $2,000, not counting experimental changes and improvements. If fine switch-boards, motors, extra-large static machines, cabinets for light-treatment, Roentgen ray apparatus, etc. are added, any sum may be expended, but these figures should not discourage the beginner, as such outlays are not necessary for a commencement and are needed only in time and in the course of a prosperous career.

When the physician interested in genito-urinary work has procured a good galvanofaradic switchboard adapted to chemical cells or commercial circuits, or both, his purchase of electrodes and other accessories should be determined by the demands of his practice. An initial outlay of $125, or, at most, $150, should provide everything with which to begin his electrotherapeutic work. The thorough electrotherapeutist will do his work with simple and inexpensive apparatus. Physicians purchase medical books from time to time, surgical instruments and other appliances when their practice requires them. Electrotherapeutic apparatus should be purchased in the same manner. An outlay of $150 will purchase the neccessary apparatus to begin work. This apparatus should be thoroughly mastered, both in its construction, care, and management, and in the technique of its application. To do good work with

electrical apparatus, the physician should use them with the same confidence and familiarity with which he uses the clinical thermometer and stethoscope. Complicated, inefficient, expensive, and non-durable apparatus have done more to put back the general use of electric currents in medicine and surgery than the whole hosts of charlatans and irregular practitioners who are so often accused of using electric currents. The student of this section cannot fail to observe that four-fifths of the best genito-urinary electrotherapeutic work is accomplished with a galvanofaradic switchboard and a few simple electrodes.

7. The galvanic battery generally used is composed of cells, elements, and fluid. Under *cell* may be understood an empty vessel for the elements, or a cell complete, containing elements and fluid. The cell proper—the empty vessel—may be made of glass, rubber, or china. The elements consist of a pair of dissimilar plates. The fluid in which the plates are immersed may be of a varied constitution.

The cell complete yields a constant and uniform current under unvarying conditions. This implies that neither the electromotive force nor the resistance of the cell shall vary, or else that as the electromotive force runs down, the resistance shall diminish in proper proportion to maintain a constant current. There is in reality no constant cell. The constancy is greatest when the external resistance is high in proportion to the internal resistance.

Sometimes dry cells may be convenient for the busy country practitioner who takes his battery in his carriage. Of late, these dry cells have been much improved, for his convenience, so that bad roads or clumsy servants cannot upset acid fluid and thereby spoil costly fabrics.

8. Galvanic batteries may be *portable* or *stationary*. The portable battery is composed of from twelve to thirty cells; those consisting of twenty to thirty cells are more commonly used. They produce a constant current as long as the circuit is closed, which means as long as the elements of the portable

battery are immersed in the fluid. As soon as the séance is finished, the elements must be removed from the fluid.

9. We have constructed a portable galvanic battery (see Fig. 1) that keeps clean, and is a convenience, particularly for travel to distant parts.

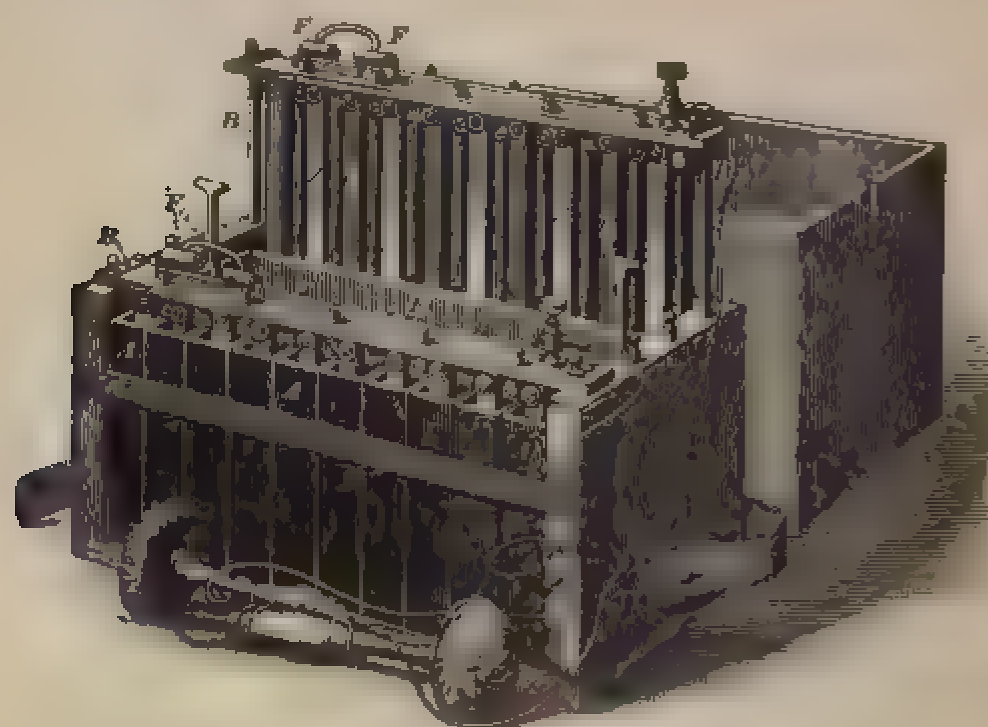

Fig. 1

Newman's Portable Galvanic Battery. Twenty Cells

A, A, A, Hard Rubber Cells 20. B, B, B, Corner Posts. F, F, Zinc and Carbon Elements. E, A Wash-Tray in Which the Elements are Cleaned and Firmly Held for Transportation

The features of this battery are:

1. It can be transported any distance, and a concentrated fluid may be kept separately in a bottle, and, when ready for the operation, diluted, and the cells filled.

2. All parts of the battery are easy of access.

3. If any element is broken, it can be changed or easily replaced, without the aid of an instrument-maker.

4. The elements are cleaned in the dripping-pan after each use, preventing any crystallization on the elements.

5. There is no spilling of fluids.

6. One-half of the battery (ten cells) can be used independently, thereby saving the zincs.

10. Cabinet Stationary Galvanic Battery.—Many different cells are used. The Leclanché cells are now generally employed. A semidry cell recently put on the market is the *Hydra cell*. It presents some advantages over other dry cells in having a very large zinc electrode that is exposed to the action of an energetic depolarizer. This is accomplished by dividing the zinc electrode in two, each in the form of a cylinder, of which one is placed in the interior of the carbon cylinder and the other exterior to same. The carbon is not alone surrounded by the depolarizer, but its exterior cavity is also filled with same. The result is that the depolarizer is

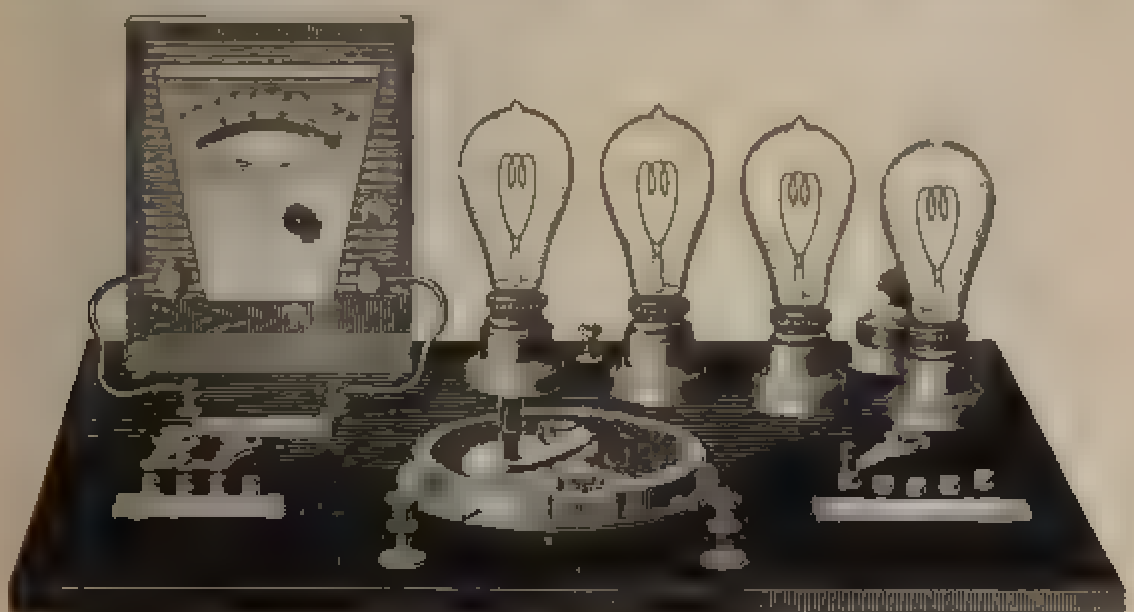

FIG. 2

Shunt Controlling-Apparatus

given an extended zinc surface on which it may act and neutralize the polarizing effects of the current.

When not in use, the liquid is more or less taken up by the absorbent material with which it is mixed, but as soon as the cell is put in action, the liquid is driven out from the interior of the carbon and serves to maintain the depolarizer around the external zinc in a moist condition. The cell is enclosed in an outer metallic casing insulated from the outer zinc cylinder by a bed of asphalt. Combinations of four cells in one box may give a current of up to 30 amperes at about 6 volts, while the smallest cell, of a size one-half of that of an ordinary dry cell, may deliver a current of 10 to 14 amperes at 1.4 to 1.5 volts.

11. Galvanism From Electric Street-Current. Fig. 2 illustrates a shunt controlling-apparatus adapted to the Edison 110-volt, direct street-current. It is a switchboard with four incandescent lamps in circuit, very light, in a box, and easily transportable. This device is designed exclusively to admit of the direct 110-volt current to be utilized for electro-therapeutic work, and is so arranged as to take the place of the more expensive resisting devices.

The system herewith arranged is well adapted to the Edison current, assuming that the physician has a rheostat and a milliammeter to utilize in conjunction with this device. It is also constructed upon a slate or marble base with a rheostat in series to modify to a minimum the various degrees of the current as required.

12. The *switchboard*, as illustrated by means of Fig. 3, is furnished by the Technical Supply Company, and is superior to any board in the market as regards efficiency, neatness, compactness, and good workmanship. It is made in the shape of a box, to enable the operator to carry it around, if necessary, from one part of a building to another, as, for instance, in a hospital, and makes it also possible to lock it up and thus prevent any handling by persons not familiar with its construction. The front is made of polished slate of high-insulating qualities, and all the various devices are fastened directly to this slate.

Behind the slate and directly supported by it is the faradic coil, likewise five dry cells for supplying the current for its primary coil, and also four resistance-coils that act as volt-selectors when the direct current from a commercial circuit is made use of. It is therefore seen that everything not absolutely necessary for the selection and variation of the current is put out of the way, and this makes it possible for the operator to handle the board with the least amount of confusion.

13. Perhaps the most important part of the board is the *ammeter*. If the use of the whole apparatus is to be satisfactory, it is absolutely necessary that the indications of the ammeter

be beyond doubt. The ammeters in most switchboards are of an inferior grade, and they are not alone unreliable as to their present indications, but the deterioration is such that their future indications may differ greatly from the present ones. For delicate electric doses, the ammeter cannot be too good, and

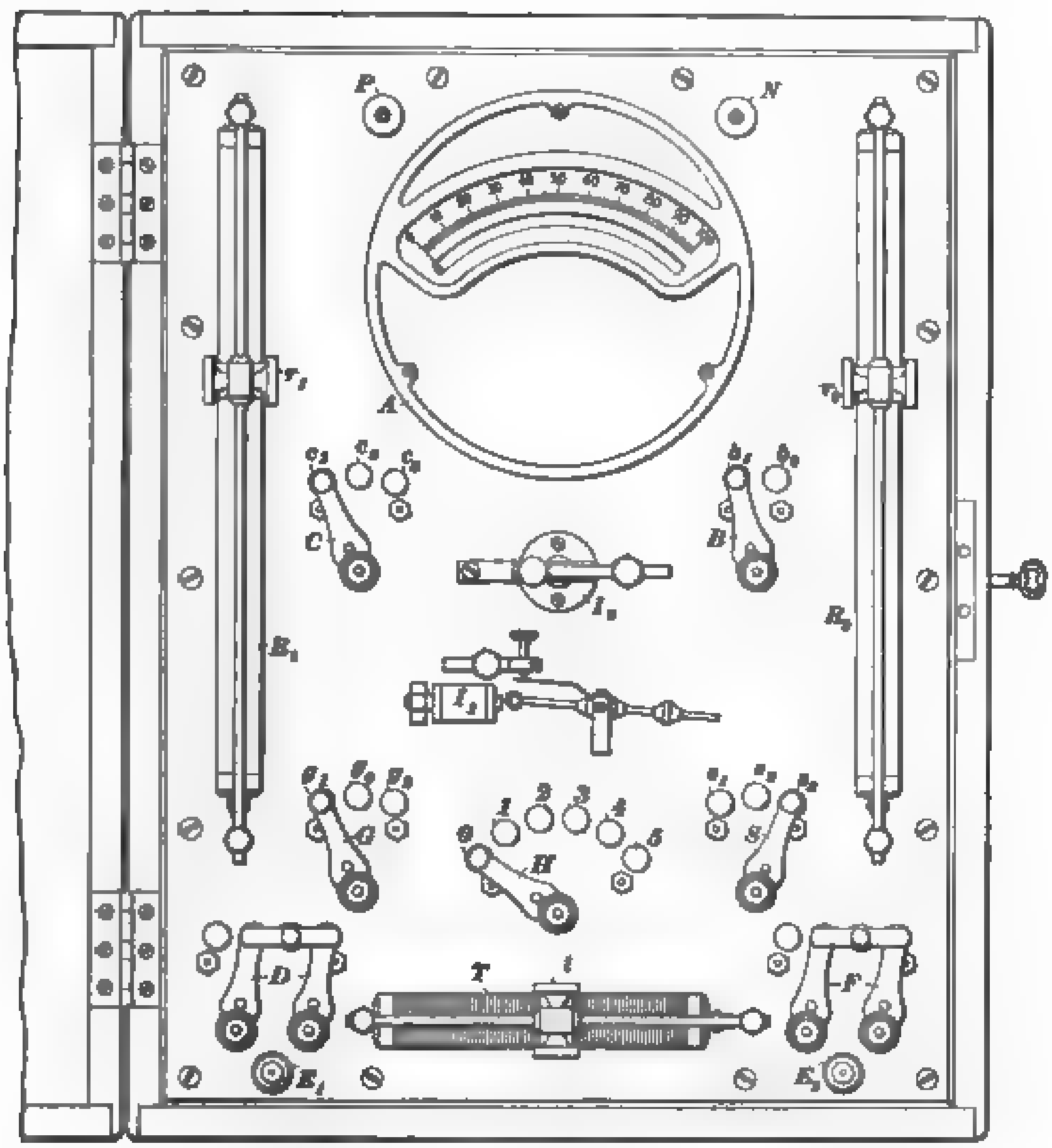

FIG. 3

Galvano-Faradic Switchboard

the board has therefore been provided with the well-known Weston ammeter, indicated in Fig. 3 by *A*. This is absolutely dead-beat, which makes it possible to make sudden variations in the current-strength without causing the pointer to fly violently all over the scale with the possibility of striking

the stops at the ends of same, and thus to cause an injury to the meter.

14. When it is desired to use the direct current of the commercial lighting circuit the conductors for the latter are connected to the two binding-posts *P* and *N*, *P* receiving the positive wire and *N* the negative. The switch *B* serves the purpose of making or breaking the connection between the lighting circuit and the various circuits of the board. In the position indicated, when the lever rests on the button b_1, the current is still cut off. To complete the connections, the lever must be moved to the right so as to rest on button b_2. The binding-posts E_1 and E_2 are to receive the conducting-cords of the electrodes with which the patient is to be treated. To bring these binding-posts in connection with the galvanic circuit the switch *D* must be moved to the left.

The board is supposed to be used with a 110-volt circuit. As this high voltage is inconvenient to handle, it is sent through four resistance-coils connected in series, each of about 200 ohms' resistance. Three of these coils are connected with the three buttons c_1, c_2, and c_3 of the volt-selector *C*. This makes it possible to supply an electric pressure to the binding-posts E_1 and E_2 of 30, 60, or 90 volts, when all resistance but the last coil is cut out, which coil always remains in circuit, leaving an extra resistance of 200 ohms between the patient and the 110-volt circuit. To reduce this pressure to zero, the sliding contact on the rheostat R_1 should be moved to its lowest position, and it should always occupy this position whenever it is desired to put the switch *B* on or off or increase the pressure by means of the volt-selector *C*. When, now, the slide r_1 is moved upwards, the pressure will increase up to 30 volts. Should this be insufficient, it is brought down to the zero position again and the volt-selector *C* moved to button c_2, giving 60 volts. By again raising the slide r_1, resistance is gradually cut out until 60 volts is supplied to the patient's circuit. If this is still insufficient, the procedure may be repeated and the selector *C* moved to the last button c_3, giving 90 volts. When once the suitable pressure has been found, the rheostat enables the

operator to make any desirable gradations in the current-strength to suit the requirements. The rheostats R_1 and R_2 are made of a column of slate, highly polished and covered with graphite, making them compact and neat in appearance.

The polarity of the two binding-posts E_1 and E_2 may be changed at any time by moving the pole-changer F either to the left or right. In its present position, E_1 is positive; by moving it to the left, E_2 will be positive.

15. When it is desired to use the faradic coil the switch B should be moved to button b_1, breaking the 110-volt circuit, and the switch D moved to the right. The current is now supplied by the dry cells connecting with the lever of the cell-selector H and buttons *1*, *2*, *3*, *4*, *5*. In the position indicated, the cells are out of circuit. On moving the lever to button *1*, one cell is connected with the primary coil of the faradic coil. The current-strength through the primary coil is regulated by means of the wire rheostat T, with the sliding contact t. There are two interrupters that may be connected with the primary coil. By moving the lever G to button g_1 the slow interrupter I_1 is switched in, and by placing the lever on button g_2 the rapid interrupter I_2 is put in action. When the lever G occupies the middle position over button g_0, both interrupters are put out of action.

16. The switch S regulates the length of the secondary coil, the buttons s_1, s_2, and s_3 connecting, respectively, with 300, 800, and 1,500 yards of No. 34 wire. If it is found that one cell is insufficient, the sliding contact t should be moved to the left, to include the whole of the resistance-coil T before the lever H is moved to any of the other buttons for the purpose of including more cells in the primary circuit.

In the faradic circuit the pole-changer F also serves the purpose of changing the polarity of the two binding-posts E_1 and E_2. The rheostats R_1 and R_2 are connected in shunt with their respective circuits, as this insures a more even regulation along the whole length of the rheostat instead of a small portion of same, as is mostly the case when a rheostat is in series with the main circuit.

17. Fig. 4 illustrates a wall-board devised by Dr. William J Herdman, of the University of Michigan. This is a very excellent arrangement of apparatus for accomplishing all electrolytic work in genito-urinary surgery. For a description

Fig. 4

Herdman Universal Switchboard

of this wall-board, we refer the student to Plate XV, Art. **469,** *Electricity in Diseases of the Nervous System.*

HYDROGALVANISM

18. The instrument illustrated in Fig. 5 is designed for applying the direct current to the various parts of the genito-urinary tract without bringing the instrument in actual contact with the parts to be benefited thereby. The principle is that of an electric bath; the electrified water gravitates into the cavities,

which are thereby expanded, so that the whole surface of the cavities is more completely electrified than it could otherwise be and without the possibility of irritation that might arise from the use of the metal electrode, the instrument being only a vehicle for conveying the electrified fluid.

THEORY OF HYDROGALVANISM

19. By this means the urethra and bladder are submitted to the action of an electric douche, the stream of water conducting the electric current to all parts of the urethra and bladder.

The theory as a practical application is well expressed by Newman Lawrence: "All that is necessary, to insure that the

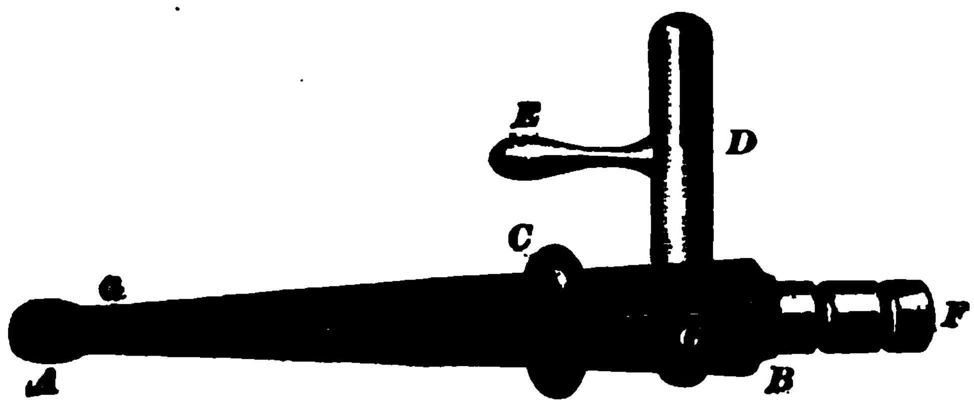

FIG. 5

Newman's Urethral Hydrogalvanic Instrument

A to B, Conical Hard-Rubber Tube. A, Small Holes for the Passage of the Fluid Into the Urethra. C, Movable Soft-Rubber Ring. D, Binding-Posts for the Attachment of One Cord of the Battery. E, Stop-Cock. B to F, Corrugated Metal Tube for the Attachment of the Rubber Tube for the Introduction of the Fluid. G, Platinum-Wire Lining the Hard-Rubber Tube for the Conduction of the Electricity

water or other fluid is electrified when it reaches the patient, is to have the nozzle so constructed that the jet or jets of water form continuous streams for a reasonable distance after they leave the metal conductor within the nozzle."

20. Description of the Instrument.—The instrument is a conical tube of hard rubber, which can be inserted into the urethra from 1 to 2 inches, and has a soft-rubber ring attached that can be pushed against the meatus to prevent leakage. A stop-cock regulates the supply of the fluid, the top of which is used as one binding-post to attach the tip of one rheophore. The other end of the tube is used for the attachment of the

rubber tube for the introduction of the fluid. The tube is lined with a platinum wire for the conduction of the electricity.

21. Modus Operandi.—The fluid used may be a solution of sodium chlorid, or sodium bicarbonate, or any other medication, as the symptoms may indicate. As a reservoir for this fluid we use a glass cylinder, so as to ascertain by sight the quantity of the fluid used. The lowest part of this cylinder and the portion of the instrument *B F* are connected by a rubber tube, for the transmission of the fluid through the instrument. The glass reservoir is placed at such a height that the fluid will, by its own gravity, enter the parts to be electrified without any undue pressure.

For the indifferent pole, use either a pad placed on any part of the body or a sponge-electrode in the hand. The active pole of the battery is connected with the instrument at *D*. The end of the instrument at *A* is slightly lubricated and is introduced into the meatus so far that the conical part fills up the orifice.

22. The Newman instrument has been made conical in order that the meatus may be filled, as its caliber and that of the urethra differ in different people. When the conical tube has been inserted as far as is intended, a rubber ring *C* is pressed against the outside of the meatus, to prevent any leakage of the fluid. One hand only is needed to keep the instrument in place, while the other one is used to turn the stop-cock *E*, which allows and controls the afflux of the fluid to the parts, and also regulates the current-strength of the battery. The strength of the galvanic current should be from 5 to 20 milliamperes, according to effects desired.

The stop-cock should be so regulated as to keep the parts well filled with the electrified fluid, or even dilated so that it enters all the rugæ of the canal. If it is desired to change the electrified fluid, the instrument may be withdrawn slightly, to allow an escape of solution, and then the stop-cock may be turned on to give a fresh supply.

The average time for a séance will be about 10 minutes. Before finishing the treatment the current of the battery should be slowly reduced to zero.

23. The hydrogalvanic instrument may be used in tortuous urethral strictures of small caliber, in which it is difficult to pass a filiform guide—the urethra being very sensitive—in order to dilate, to lessen the tortuosity, allay the irritability, and heal up any sore or bleeding-point, and thus prepare the case for the regular electrolytic treatment. This, as a rule, is not necessary for the expert, but some operators may find the hydrogalvanism an aid in beginning the treatment, particularly when they find difficulty in introducing an electrode, or even a filiform guide.

Hydrogalvanism has been conveniently used in these cases with marked benefit, and has cured several cases in which other methods only partly allayed the severe symptoms. If inflammation is present, the introduction of instruments is generally very painful, and often causes derangements of the bladder.

24. Diseases of the prostate consist mostly of inflammations and hypertrophies, and what has been said about inflammation of the seminal vesicles may also be applied to prostatitis.

"Obedient to surgical principles, no instrument may be introduced into the urethra while it is acutely inflamed. The only exceptions thereto are when a foreign body requires removal or when retention demands relief by the catheter, after other means of voiding the bladder have failed."

In these cases of inflammation the hydrogalvanic application will, and undoubtedly does, produce sedation of these parts, and it will facilitate the after-treatment with other applications. It is a new field in prostatic diseases, and the probability is that it will cure some maladies of the prostate gland, supersede the former "do-nothing plan," and the present tendency toward cutting operations. So far, hydrogalvanism has allayed irritation, cured prostatitis, and some cases of impotence.

25. Urethritis.—The failure to abort *urethritis* has been due principally to the fact that the inflammation has caused such an irritable and painful state that it is impossible to introduce an instrument, syringe, or any medication. The important part is to make use of a certain stage in which the inflammation has assumed such a degree of irritability that the instrument under consideration can be used. This, or a

found sufficient in most cases, for stronger currents are apt to overstimulate and even cause inflammations and consequent discharges. The success depends on sound judgment, careful manipulation, and a perfect understanding of the instruments and the laws of electricity. The solution used in many cases is plain water, but salt-water or any other medication may be used as indicated.

31. Hydro-electric methods are nothing less than the electric bath localized to a certain part of the body, the current being transmitted either by pure or medicated water. The instrument devised by us is introduced to physicians for what it is worth and solely for the good it has done, and nothing more is claimed. Hydrogalvanism by this instrument will not replace the direct electric current applied through metallic electrodes. The hydrogalvanism in genito-urinary surgery wrongly applied by the tyro in electricity may do harm, but scientifically conducted it is useful, and in many cases paves the way for other treatment or other applications of electricity.

If the galvanic battery is omitted, the same apparatus is used for the irrigation of the urethra and bladder. For the urethra, it can be applied in urethritis and gleet. In diseases of the bladder, it acts as an irrigator, used for washing out and dilatation. In cystitis, hot water will allay the pain and spasm. The fluid enters the bladder by the siphon action and gravitation, without irritating the neck of the bladder or urethra. If the glass reservoir is lowered, the siphon's action will reverse the current and empty the bladder of any fluid. This apparatus is handy, portable, can be used in any place at a moment's notice, and for these reasons is superior to any other appliance arranged for a similar purpose.

32. Indifferent Electrode.—Long experience has taught us the advantages of a thorough understanding of the composition and location of electrodes. Among the electrotherapeutic appliances used by physicians, electrodes occupy a very important place. On the construction of electrodes depends the current-strength that a patient can tolerate and, therefore,

the therapeutic results that can be obtained. We desire to call your attention here to the indifferent electrode, particularly when that electrode is made positive.

As the negative pole is employed in the treatment of strictures, the positive pole becomes the so-called indifferent pole. The term "indifferent" applied to the inactive pole is unfortunate, as it has certainly contributed to render physicians negligent both as to the nature of the metallic base and the location of the electrode. The nature of the metallic base is not important when the indifferent electrode is negative. The conditions, however, are entirely changed when the negative pole is active and the positive is indifferent.

33. The composition and location of the indifferent electrode should be given every care. With regard to the composition of the electrode, two factors should be carefully studied, namely, (1) the nature of the metallic base of the electrode; and (2) the spongy material that should separate the metallic base from the skin.

As a protective between the metallic base of the electrode and the skin, about sixty layers of surgeon's gauze, as recommended by Dr. J. Bergonié, serve admirably. This gauze is always at hand; it is easily sterilized and always acceptable to the most fastidious patient. The number of layers and dimensions of the gauze will be determined by the current-strength employed. The nature of the metallic base is of the utmost importance and demands careful study. If, for example, the metallic base is copper and the surgeon's gauze is saturated with a sloution of sodium bicarbonate, on closing the circuit there is at once formed the oxid and carbonate of copper. These products of electrolysis are extremely bad conductors. A small piece of copper used as the base of an electrode offers 10 or 15 ohms resistance, but when covered with oxids and carbonates of copper, the resistance at once increases to thousands of ohms.

The best metal to use as the base of the electrode is platinum, but the price of this metal excludes its use. The next best metal is aluminum. This metal is cheap and it is extensively used in commerce today. Next to aluminum as a

metallic base comes block tin; then, nickel, copper, brass, and zinc.* We therefore recommend that either aluminum or block tin be used as the metallic base of the electrode when the positive pole is made indifferent, and that the protection between the metal and the skin be composed of sixty layers of surgeon's gauze. By using these metals as the base of the positive indifferent electrode, eschars may be prevented and the current will be less painful on account of diminished voltage.

ELECTROCAUTERY AND ELECTRO-ILLUMINATION

34. The current used for electrocautery, as well as for electro-illumination, may be either the direct or alternating. The electric current is not applied direct as a therapeutic measure, but used to heat a wire or light a lamp; it is only an accessory means of diagnosis by means of light or treatment by means of cautery. Electrocautery is an improvement on former cautery measures, because the heat used can be regulated and kept heated to the same degree.

For electrocautery we may use: (1) plunge batteries, two elements and one acid, which are primary batteries; (2) secondary, or storage, batteries; (3) dynamos; (4) the street-current by adaptors or controllers.

The prime object in using an electric current for cautery purposes is to generate heat, to keep the cautery-blade or cautery-loop at the required degree of incandescence. We need from 7 to 50 amperes of current for heating a burner or wire, according to the size and material of the burner employed. A rheostat to regulate the heat wanted and to maintain such is absolutely necessary. One good battery with a rheostat to regulate the strength of the current is sufficient for all kinds of work. An ammeter is sometimes necessary, as in the Bottini operation.

35. The galvanic battery that we have considered for the medical and surgical applications cannot be used for cautery-work, as it will not heat sufficiently any burner of a good size. For cautery, the battery must be constructed for quantity;

*Dr. H. Bordier, "Archives D'Électricité Médicale," October, 1901.

therefore, it must have large plates and few elements with only a slight internal resistance. The external burner should be the point of highest resistance in the circuit, since it is here that the heat must be developed. Therefore, all parts composing the external circuit are made of large size, so that they may offer as little resistance as possible. These external parts are the connections, cords, handle, burner, or loop wire, écraseur, etc.

36. All primary batteries have the disadvantage of polarization; the heat first generated cannot be maintained and will grow less in time. In some operations, the same degree of heat must be maintained for 10 to 20 minutes and even longer. To prevent the polarization, the fluid in contact with the elements must be displaced constantly, so that the gases and other ions which may accumulate on the plates are washed off, and a new part of fluid comes in contact with the plates to replace the used and weakened fluid. This is done in several ways: either by moving the plates by rocking in a to-and-fro motion or by a kind of a scraper that operates like a pump running up and down, thereby scraping the elements clean and also replacing the fluids. All modern cells use chemical means to prevent polarization.

37. Dynamo circuits are often a convenient source of electric energy, and when the supply can be obtained from this source all the annoyances that may arise in the use of other means are avoided. However, the question arises whether this way is economical or safe, both being very important. (See Art. **40**, *Essential Apparatus.*) Adapters, or controllers, have been used with the street-current. There are many different varieties manufactured. While the street-current is very convenient for office use, there is always a question if it is safe to use and if the storage-battery is not the cheaper.

38. Advantages of Electrocautery.—Electrocautery has many superior advantages, among which we mention the following: (1) The avoidance of hemorrhage, primary or secondary. (2) Exemption from sepsis and its dangerous complications. (3) Its germicidal effects on deep-seated tissues far beyond the cauterized surface, as in cancerous infiltrations.

(4) The power of controlling and limiting its field of action in delicate and out-of-the-way cavities and parts. (5) Unlike other forms of actual cautery it is free from the destructive effects of radiated heat on adjacent healthy structures. (6) It is the only means known by which a continuously heated wire may be made to surround and remove tumors or to destroy pyogenic membranes of fistulous canals.

ILLUMINATION

39. The illumination of cavities in the body, particularly for a satisfactory ocular inspection, has difficulties; in fact it has so many uncertainties that some operators have returned to the old methods of reflecting light, either sunlight or artificial, by a mirror. The difficulties to overcome are principally: (1) The accurate adjustment of the focus of the optical part, as any alteration in the distances will disturb the clearness of vision. (2) The burner, which transmits the light, is another source of irritation, as a direct burner lights both ways and blinds the operator, and any transmission by reflection weakens the light at each angle.

40. Source of Light.—Storage-batteries are good, but are rather heavy for portable uses, and need great care to keep them in repair and well charged. Plunge-batteries polarize and thereby are uncertain in action. The best light is at the end of the tube at or near the cavity to be examined, if it can be protected sufficiently so that the instruments used do not interfere with the burner. If small lamps needing only a low current of amperage are employed, dry cells may be used, which will make the apparatus more portable.

41. An Improved Cystoscope.—"A New Cystoscope for the Simultaneous Catheterization of Both Ureters, and for Return-Current Irrigation of the Bladder," by Frederic Bierhoff, M. D., New York City. This is an instrument designed to facilitate the catheterization of both ureters during the one sitting, and to leave them à demeure. It is a modification of the Nitze-Albarran single ureter-catheter cystoscope. The modification consists in the use of two separate tubes to convey the

ureter-catheters, and two knee-mechanisms, controlled by the same screw, to allow the curvature of the catheter, the whole being in one movable sheath, which surrounds the shaft of the cystoscope, Fig. 6 The method of use is as follows: A black

FIG. 6

A New Cystoscope for the Simultaneous Catheterization of Both Ureters, and for Double Current Irrigation of the Bladder

ureter-catheter is inserted into the cannula on the operator's left hand and a brown one into the right. The instrument is then inserted in the same manner as the old cystoscope and one of the ureters sought for and catheterized (the catheter being inserted about 4 to 5 centimeters into the ureter). The

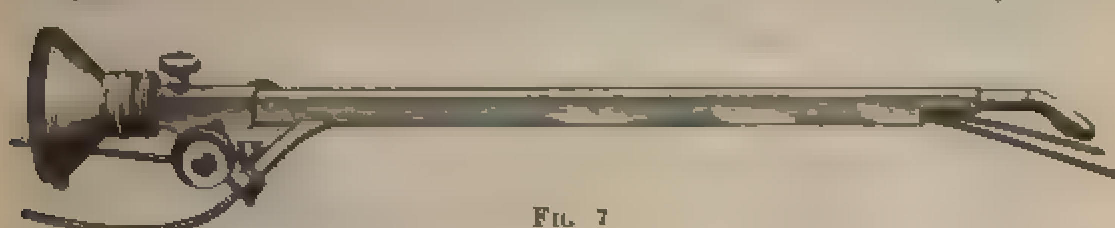

FIG. 7

knees are then turned down again and the other ureter located. During this latter procedure the first catheter moves out of the field of vision and may be entirely disregarded by the operator. The second ureter is now catheterized, the knees again turned down, and the instrument turned so that the operator may

FIG. 8

assure himself before withdrawing it that both catheters are in situ (see Fig. 7). The lamp is then extinguished and allowed to cool, and the cystoscope turned upwards within the catheterizing portion, so that the beak points toward the middle line of the abdomen (Fig. 8), the catheterizing portion meanwhile

being held and continuing to point downwards. The instrument is then slowly withdrawn, its removal being compensated for by a gradual insertion of more of the catheters into the cannulæ. When the knees of the instrument and the catheters appear at the meatus, the catheters are held at the urethral orifice with one hand and the cystoscope steadily withdrawn with the other. In the course of the operation the black catheter will enter the left ureter, and the brown one will enter the right. It will then be an easy matter to collect the separate urines and distinguish that flowing from each kidney.

Should the fluid become turbid during the operation, the catheters and screw-caps on the cannulæ may be removed, the stop-cocks and rubber tubes inserted into the cannulæ, and the double-current irrigator employed before again refilling the

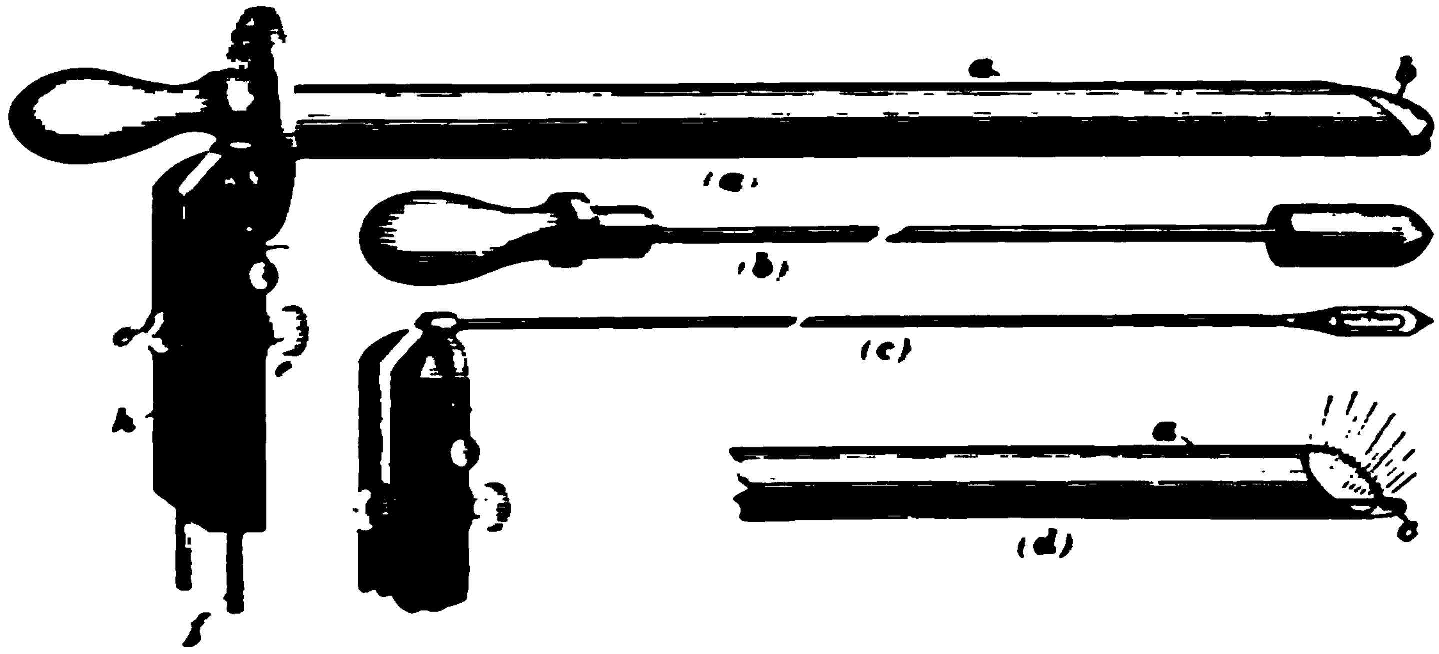

FIG. 9

bladder, the instrument remaining in situ. This instrument retains the size of the old single instrument of Nitze-Albarran (average 23 Charrière).

42. Other examinations for diagnostic purposes are made by exploring the bladder with a *bougie à boule*, or sound, and by injection or irrigations of the bladder, in order to find the capacity of the viscus, the state of the walls, its mucous linings, abnormal contractions, and the sensibility of the patient.

The systematic handling of the cystoscope to gain a concise knowledge of the topography of the bladder can only be acquired by extensive practice. Obstructions to the view may

occur, mostly by blood or pus covering the mirror, but an improvement has been made to wash away such impediments with a stream of water. The cystoscope requires a current of 7 volts in order to have a good light.

43. The Urethroscope, or Endoscope.—The *urethroscope*, or *endoscope*, for examining and treating the urethra and even the prostate, is perhaps the most important instrument in electric lighting. Fig. 9 illustrates an improved form of the urethroscope. For a description of this urethroscope, see Art. **40**, *Physics of Light and Cautery*.

FARADIC CURRENT

44. The *faradic current* is a designation used in electrotherapeutics for the alternating induced current of comparatively high electromotive force, such as is given by an induction-coil or a magneto-generator. There are primary and secondary (induced) currents. The secondary is an alternating current, one that goes in opposite directions at each make and break of the circuit, which makes it impossible to measure the electromotive force with meters described before and used to measure the constant current.

45. The *physiological action* of this current is particularly stimulating and tonic, general and local. It is a stimulus to the contractile tissues, both directly and through their motor nerves, partly by its sensory nerves, and in a reflex manner through the vasomotor system, producing increased vascular activity in the parts it reaches. This current is also used as an alternative, by producing an excitation of the motor and sensory nerves, acting quickly on the cutaneous nerves, and exciting reflex action. There are uses of this current in genito-urinary diseases, particularly as a general tonic and controlling the spasmodic actions of certain organs. Constant improvements of the instruments in great variety will make the employment of it more frequent. The high-tension current has been much improved and is now often used with good effects.

SINUSOIDAL CURRENT

46. D'Arsonval introduced the *sinusoidal current* into electrotherapeutics in 1893 The apparatus from which the sinusoidal current is derived is growing steadily in favor. The simplicity of this apparatus and the ease with which it is manipulated account in some measure for its growing popularity. The real cause, however, for its widespread use is its wonderful influence over the symptom pain and its capacity to modify the nutritive processes of animal life. The sinusoidal current has a direct action on the nervous system of vegetative life—on the great sympathetic, independent of its action on the neuromuscular system

With low frequencies applied to motor points, the sinusoidal current produces energetic, undulating, painless contractions.

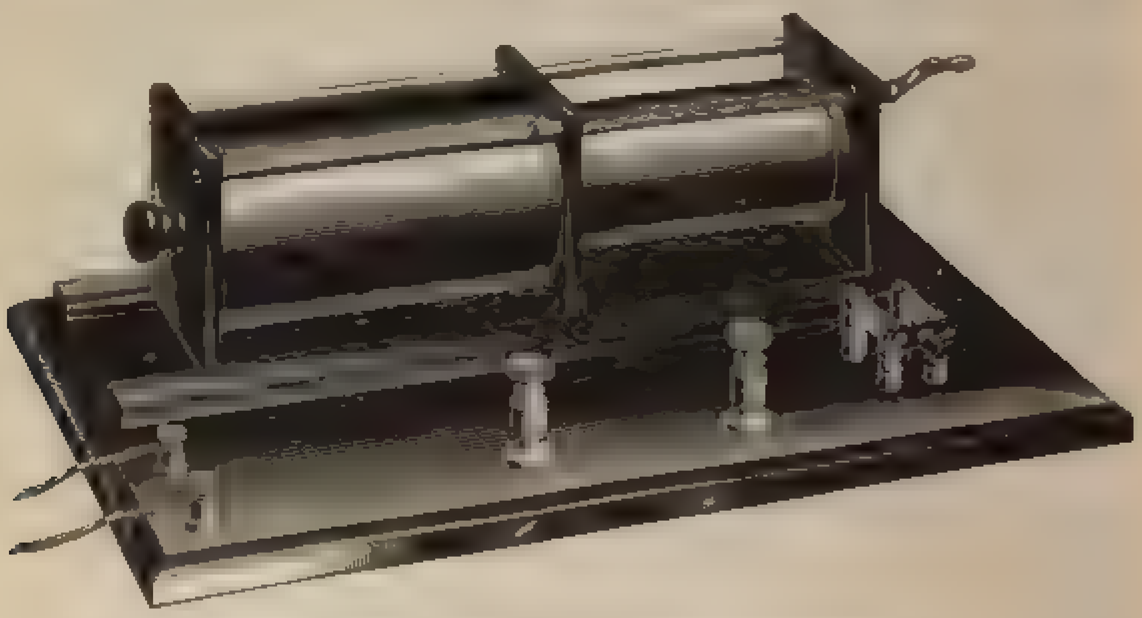

FIG. 10
Sinusoidal Apparatus for Alternating Current

With high frequencies, tetanic contraction is produced, which lacks, however, the cramp-like sensation caused by the galvanic and faradic currents. Both as an excitant and sedative to contractile tissues, sinusoidal currents have a wide range of use.

47. Method of Application.—The electric bath is a very satisfactory means of administering the sinusoidal current For a description of this bath and its accessory apparatus, see *Physiology of Alternating Currents and Hydro-Electric Methods.*

A healthy individual placed in a bath through which a

sinusoidal current is passing will first observe a mild general tetanization of all the muscles of the body. A general sensation of being lifted from the water is experienced. This action of the current is followed by increased respiratory capacity, the absorption of oxygen by the blood-corpuscles being increased

FIG. 11

Kennelly Sinusoidal Apparatus

20 per cent. In chronic congestion of the different organs of the body, a marked diminution of their size is observed after a course of sinusoidal baths. The importance of this action in cardiac and hepatic conditions is obvious. The secretion of urine is also considerably increased. The current serves to stimulate the muscles of the peripheral capillaries, which are

paretic from distension This energy imparted to the peripheral circulation gives new vigor and tone to the central organ of circulation.

The genito-urinary surgeon will find in this current a reliable therapeutic agent in various pathological conditions that are very common in his routine practice.

48. Sinusoidal Apparatus.—For physicians who have the alternating current in their office, a very efficient sinusoidal apparatus has been arranged in the following manner by Gautier et Larat: The current is taken directly from a 110-volt

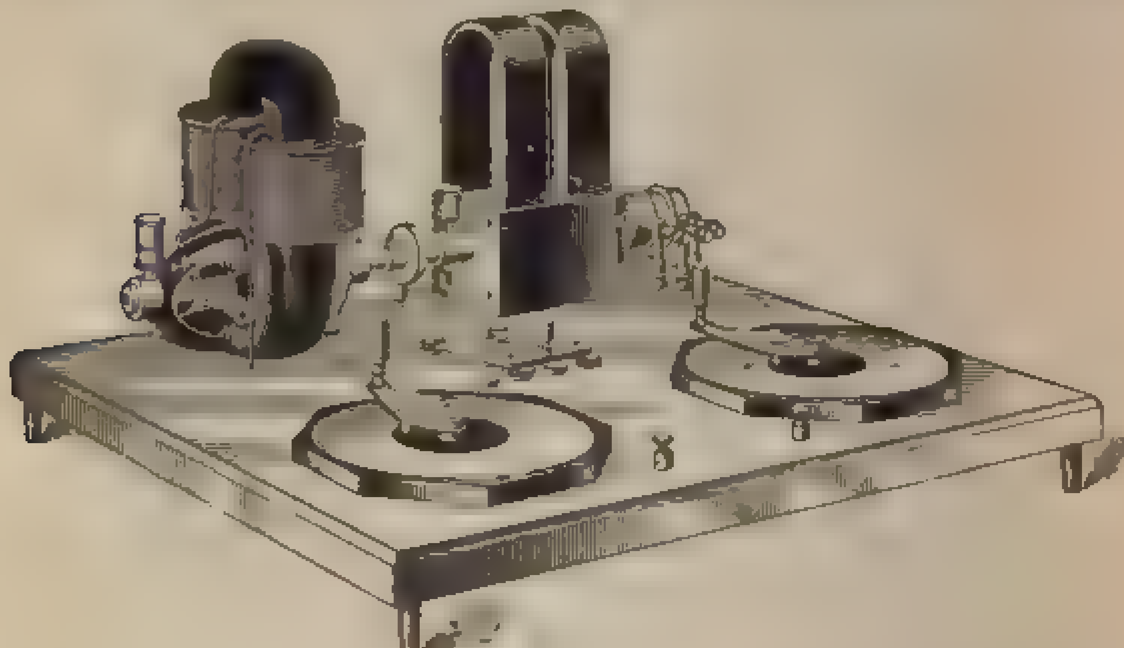

FIG. 12

McIntosh Sinusoidal Apparatus

alternating current with a 30-candlepower lamp interposed as a resistance. The current is then conducted directly from the lamp to the primary of an induction coil. The current used in the bath is taken from a secondary coil constructed on the Dubois-Reymond type, Fig. 10 In this arrangement the frequency of the street-current cannot be changed. The current-strength is regulated by the degree in which the secondary coil overlaps the primary. The Kennelly sinusoidal apparatus is very convenient and serviceable, Fig. 11. For its use the 110-volt direct current is required. Another sinusoidal apparatus now in very general use is manufactured by the McIntosh Battery and Optical Company, Fig 12.

49. The general bath, as a means of administering the sinusoidal current, necessitates disrobing. This is somewhat inconvenient and requires some time. A very efficient and convenient substitute for the general bath is the bath with four electrodes, as illustrated in Fig. 13. The patient is placed in a chair, the seat of which may be adjusted to suit the size of the patient. There are four separate cells, one for each of the arms

FIG. 13

The Four-Celled Electric Bath by Doctor Schnée

and legs, each having two electrodes. The conductors *a*, *b*, *c*, *d* from each of the cells are connected to separate plates *I*, *II*, *III*, *IV* on the switchboard *S*, shown enlarged in Fig. 15. Each of these plates may be connected either with the positive strip *A* or the negative strip *B*, the first being connected with the positive conductor *p* and the latter with the negative conductor *n*. For the purpose of making these connections, the switchboard

is provided with the holes a_1, b_1, c_1, d_1 and a_2, b_2, c_2, d_2 into which any of the plugs P_1, P_2, P_3, P_4 may be inserted. As shown in

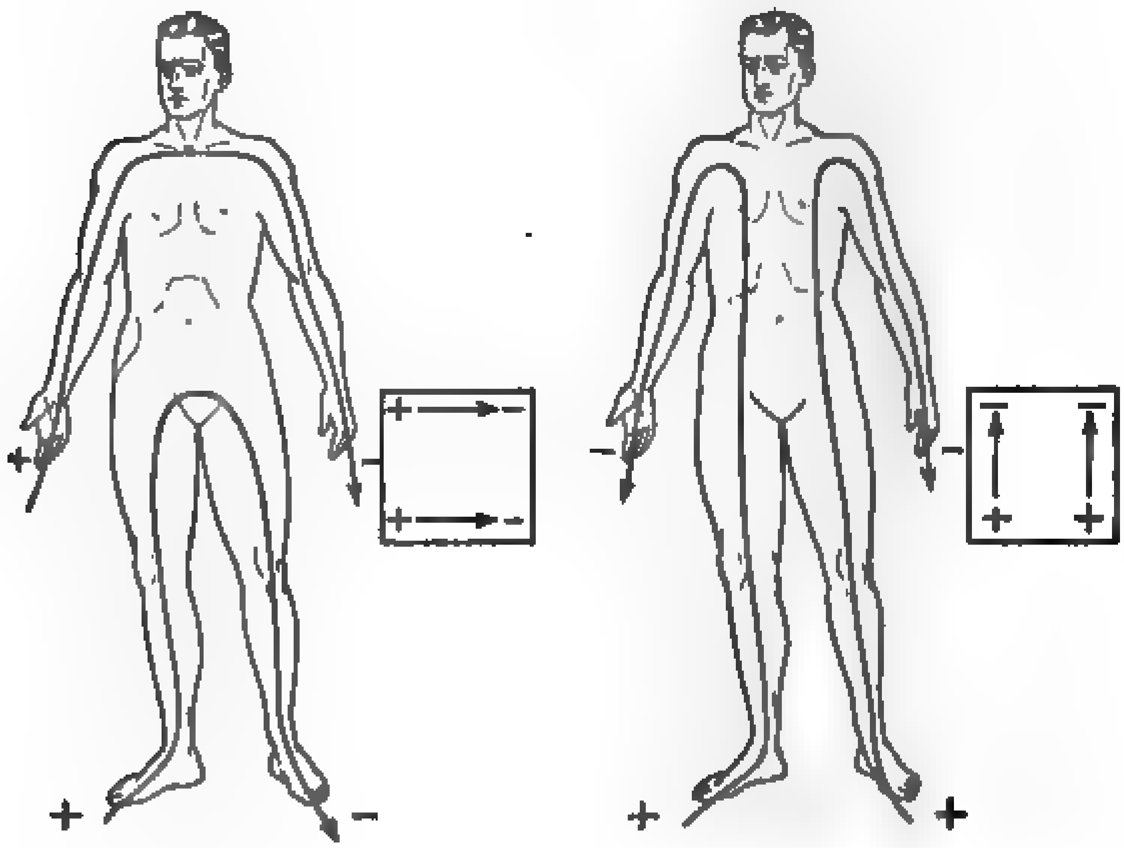

FIG. 14

the illustrations, the plug P_1 connects the plate *I* with the positive strip *A* and plugs P_2, P_3, P_4 connect the plates *II*, *III*, *IV* with the negative strip *B*. These four plugs may be rearranged to suit any requirement. Fig. 14 shows the direction taken by the current, according to the disposition of the current-terminals. The electrodes used in applying the faradic current serve also in the therapeutic uses of sinusoidal currents. Enclose a bipolar vaginal electrode in the palm of the hand, and, with the sinusoidal current of high frequency, observe the effects produced as the current-strength

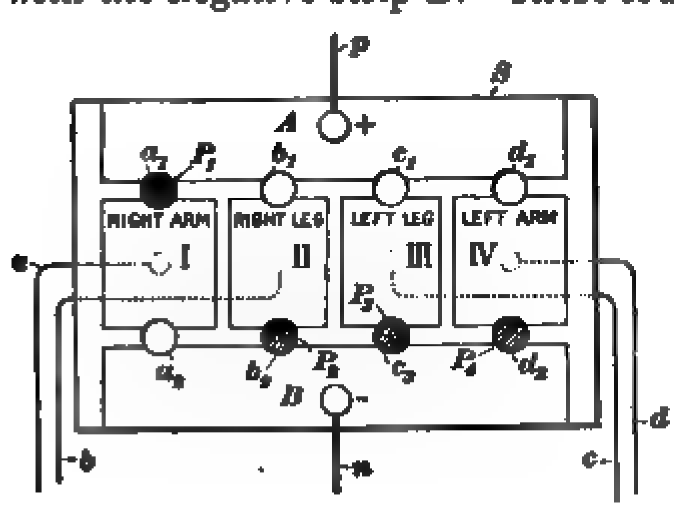

FIG. 15
Switchboard

increases to the point of toleration. This experiment will suggest many therapeutic uses of the sinusoidal current in the painful and congested conditions of the genito-urinary tract.

STATIC CURRENTS

50. "The year's fashionable drugs come and fade like a line of specters, but the electrostatic machine stays with us."* The history of electrotherapeutics of the static machine may be divided into two periods: (1) the period of the spark, from 1734 to 1880; (2) the period of the spark and spark-gap currents, from 1880 to the present date. The spark-gap currents are now generally known as *Morton currents*, having been originated and described by him in a series of articles appearing at various dates and in different journals from 1880 to the present time.

A striking fact that we have verified by extended observation is that when a physician has once acquired a working knowledge of a good static machine he continues to use that machine year after year with increasing benefit to his patients and constant satisfaction to himself. The thought of discarding it or procuring a substitute for it never occurs to him. He uses it with a feeling of certainty born of observation and experience, and he awaits the results of its action in the same security as he does those of quinin in malaria or mercury in lues. For information on this subject, we refer our students to *Technique and Physiology of Static Currents.*

The efficiency of a static machine will depend a great deal on the attention devoted to it. It does not require much care, but what it does require must not be neglected. A few minutes daily, a general overhauling once a year, with attention every month or two to the chemical in the case, will keep a static machine in first-class order and always ready to generate a current.

51. Doctor Snow uses the wave-current, particularly in two diseases, as follows:

"Impotency, or sexual neurasthenia, on account of its

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*W. J. Morton, M. D., New York Medical Record, December 9, 1899.

association with hypochondria, is favorably influenced by the psychical effects of the wave-current. The local vibratory action of a strong current applied in the rectum may often be felt to the end of the penis. This administration should be continued for at least 20 minutes and may be followed by application of sparks to the perineum and friction sparks to the penis if the case demands it. The tonic nutritional effects of the treatment is certainly one of which the physician can conscientiously make much to the patient and either cure him by suggestion or the physical effect of the current, or both.

"In the treatment of prostatitis, acute or chronic, the idea of suggestive therapeutics fails, but the results of the wave-current administrations in these cases is triumphant indeed. The application should be made by electrode about 5 inches in length and $\frac{3}{4}$ inch in diameter, being concave on the anterior surface to conform to the convexity of the prostate gland. The length will be sufficient to reach the seminal vesicles and include them in the administration.

"The spark-gap in these cases should be regulated as in all painful and inflammatory conditions—gradually increased as tolerance permits. The tolerance of the current in this region should allow the use of a spark-gap of from 6 to 12 inches before the close of each administration.

"The effects on the local condition are to promptly relieve all symptoms of congestion, pressure, and irritation. As a rule, these cases of neurasthenia need no other treatment, and are relieved of the nervous condition immediately on the institution of treatment. The impotence arising from sexual neurasthenia, in which there is lowered cellular vibrations for which strychnin and like remedies are prescribed, is greatly benefited by the administration of heavy sparks down the spine, and particularly in the region of the center controlling these organs. This treatment should also be supplemented by sparks applied to the muscular system, generally for its beneficial effects in metabolic processes and for its invigorating effects on the nervous system generally. It is a fact that heavy sparks applied over any of the organs have the power to modify the function of the organ."

STRICTURES

52. All *strictures*, no matter in what part of the body they occur, are obstructions or a narrowing of the caliber of the part caused by pathological formations of new tissue-elements. These pathological conditions may be within the caliber or outside surrounding it. Such formations take up a certain space and encroach on the walls, pressing from the circumference, thereby diminishing the caliber, or lumen, of the part affected. These structures are generally of a fibroid nature; but they may also be plastic bands passing from one wall to the other. Surgeons use different means in the treatment of this obstruction, which in many—we may say in most—cases do not cure the patient, because the new pathological formation is not removed. We depend entirely on the absorption of this pathological formation by electrolysis for a sure cure.

The chemical action of electrolysis causing the absorption of proliferated cell-elements is based on well-known principles of electrophysics, and its action is similar in all cases. But this action is so little known by the medical profession and is of such paramount importance that a chapter giving in detail the action of electrolysis is inserted here that the student may become familiar with this important subject.

ELECTROLYSIS

53. Definition.—*Electrolysis* is the decomposition of a compound body in solution by an electric current—a chemical decomposition. The body to be decomposed must be a conductor and possess certain elements to be an electrolyte, and as a compound body, must contain water and a salt. Acting in conjunction with this chemical action of electrolysis is that of *cataphoresis*, which by some authors is considered an important factor in electrolysis. The explanation lies in the direction of the current, between the elements from zinc to carbon, of the galvanic battery, or the current from electronegative to electropositive. In the external current, between the anode and the cathode, the direction of the current is directly opposite, and

the particles of the fluid gather at the electronegative pole, which is the cathode.

54. The action of cataphoresis is explained minutely by the following facts: The electrode connected with the positive pole of the battery is called the *anode*, and the one with the negative pole is called the *cathode*. The decomposition of the electrolyte is the splitting up of its molecules into their elements or atoms, which are called *ions;* hence, *anions* appear at the positive, and *cations* at the negative, pole. The ions may be single atoms of an element or molecules. Nicholson and Carlisle discovered this process of electrical decomposition in the year 1800, and electrolyzed water into oxygen and hydrogen; therefore, the theory is not new, and can be found in any textbook on elementary physics and chemistry.

55. Pure water is not decomposed by the weak currents used in electrotherapeutics, but this difficulty is readily overcome by

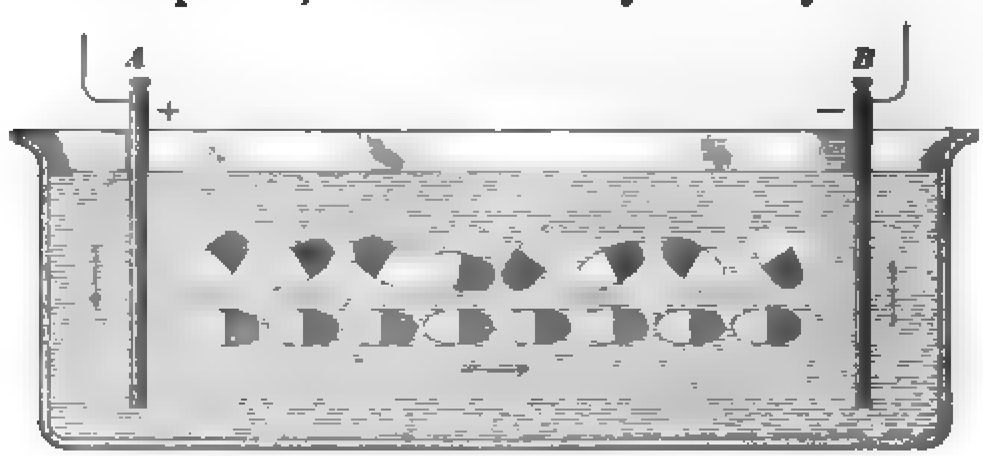

FIG. 16
Electrolysis of Water

adding to the water a salt, thereby making a compound, which is a better electrolyte, as it is more readily decomposed into its elements. Common table salt is used for this purpose, but the chlorin liberated in the decomposition tarnishes the positive electrode; hence, bicarbonate of soda is preferable, and a 5-per-cent. solution is about right. Fig. 16 will better explain the action of the electrolysis inside the battery and at its poles.

The molecules are arranged so that the oxygen is turned toward the positive electrode *A* in the upper line, while in the lower line the molecules are arranged in a chain across the liquid.

The atom of oxygen nearest the positive electrode is thus liberated as free gas, and the 2 atoms of hydrogen combine with the atom of oxygen directed to it in the next molecule and form a new molecule. This action extends throughout the chain, and, ultimately, the two atoms of hydrogen of the last molecule, having no further molecules to split up, are liberated as free oxygen gas at the negative pole *B*. It is clear, therefore, that the accumulation of the elements of the electrolytes so decomposed is at each respective pole, which is *polar*. From experiments made, it is certain that the principal action of electrolysis is at the poles. Hence, it is necessary to test the poles of the battery and see first that the galvanic battery is in perfect working order.

ACTION OF THE POLES

56. The action of the poles is very different in electrolysis; hence, each has its own function. The positive pole attracts the acids and the oxygen from the tissues, and coagulates blood. The negative pole attracts the alkalis and hydrogen, and coagulates albumen and causes absorption. Hence, the positive pole acts and burns like an acid, which is not only exceedingly painful, but may leave a hard, resilient cicatrix. On the other hand, the negative pole acts more like a caustic alkali, which does not hurt so severely during the application, and leaves, if carried to excess, a cicatrix that is soft and retractile. From this, it is evident that for the immediate destruction of tumors and for strictures the negative pole should be selected. Electrolysis requires the presence of water, and that you will find in every tissue in the human system.

As it is most important to distinguish the poles, and as we cannot trust to the marks of the instrument-maker, we must always ascertain which is the positive, and which the negative, pole.

TESTS FOR THE IDENTITY OF EACH POLE

57. We have five principal tests for the identity of each pole: (1) The water test; (2) the meat test; (3) the decomposition of a salt; (4) test by galvanoscope; and (5) by the polarity distinguisher.

1. *Water Test.*—The simplest and best method is the experiment that we make for testing the battery. Immerse two electrodes in the form of platinum needles in water and you will see the hydrogen at the negative pole, which shows itself in distinct bubbles, like pearls, around and above the needle, sparkling almost like carbonic acid in an effervescence.

2. *Meat Test.*—The poles of the battery in the shape of two needles (platinum are best) are inserted in a piece of raw fresh meat. After the electrolytic action has been allowed to take place for a while, the difference in pole-action can readily be observed. Even the application of [illegible] minutes shows an effect. Five milliamperes of current shows different decompositions in 5, 10, and 20 minutes. The positive pole has made the meat black around it—almost charred and destroyed it—while at the negative pole the color is different, being nearly white, and bubbles of the hydrogen gas appear like a white froth. While electrolysis is in active operation a hissing sound is heard at the negative pole, and the positive is noiseless, blackens the meat, and litmus paper applied to it shows, by its red color, an acid reaction.

Another phenomenon is the tenacity of the positive needle to the piece of meat. The needle at this pole is firmly adherent to the meat and can be removed only by using force, tearing away some of the products of electrolysis. This is very important for the operation, as the closure of blood-vessels will be reopened again by a forcible removal of the needle. The needle or electrode at the negative pole is so loose that it will drop out by gravity, which is another proof of the absorbent action of the negative pole.

A piece of fresh meat still contains water enough to be an electrolyte, while the living body in which the circulation is active is a better. A dried-up piece of meat is no electrolyte.

PRACTICAL EXPERIMENTS.—We have made on pieces of meat and pathological specimens, particularly with carcinoma, the following experiments:

(*a*) Into a piece of raw fresh pork two large platinum needles were inserted, at a distance of 3 inches. The current from a galvanic battery of thirty-five cells was allowed to pass

for 15 minutes, after which time the meat between and around the needles was thoroughly changed into a soft pulp. A weaker current caused changes accordingly; the current of five cells produced distinct effects in 5 seconds, twenty cells in 1 second.

(*b*) Into a piece of meat containing a bone in its center, the needles were inserted at a distance of 2½ inches from each other. One large platinum needle was then connected with the positive pole, while two small steel needles were connected with the negative pole. These needles were inserted close to the bone, and one directly into the bone-cells. The galvanic current of thirty-five cells, in 15 minutes, produced changes in the entire tissues, so that even the bone around one negative needle was entirely destroyed. Moritz Meyer, of Berlin, has electrolyzed with perfect success the bony tumor of a boy's forearm, but needed for it 118 séances.

3. *Decomposition of a Salt.*—If, for instance, a solution of iodid of potassium be subjected to electrolysis, one equivalent of hydrate of potassium will be liberated at the negative pole,

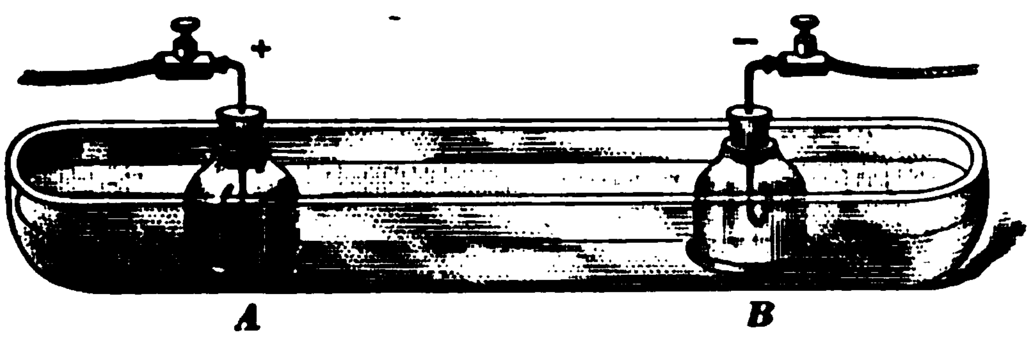

FIG. 17

Electrolysis of Solution of Potassium Iodid

showing that the potassium liberated from combination with the iodin has combined with some of the surrounding water. This can be illustrated by simply holding both poles in the solution while the galvanic battery is in action, or better in a U-shaped vessel.

This experiment, however, is more strikingly demonstrative and original when made in the following manner: Two small glass vials are filled with a solution of iodid of potassium. The bottoms of the vials are substituted by pieces of pig's bladder, the necks are then stopped by corks, through which platinum wires run, one end of each being immersed in the solution and,

the other attached to a pole of the galvanic battery. Both vials so closed are placed in a dish of water; they are 6 inches distant from each other. There is no communication between them except the water, and as long as the battery is at zero, no change takes place in the solution, which is transparent and undisturbed. A change, however, takes place as soon as the battery begins to act. Only six cells are in circuit, and almost immediately in the vial connected with the positive pole streaks of yellow appear, and in about 5 minutes the vial contains only a dark, yellow fluid, which is the iodin set free at this pole. At the negative pole the contents of the vial remains clear, only bubbles of froth welling up. This is the hydrogen set free from the water. The result of this electrolysis is iodin, oxygen, and hydriodic acid at the positive pole, while at the negative pole we find hydrogen and potassium. In order, therefore, to introduce iodin into the tissues from a solution of potassium iodid, it is first necessary to decompose the potassium solution by means of positive electrolysis, and then connect the decomposed solution to the negative pole, making the positive pole indifferent.

If this same experiment is tried with a faradic battery, no change whatever takes place in the solution. This is another proof that the action of the galvanic current is widely different from that of the faradic, and that for the electrolysis a galvanic current only can be used.

Any compound body or salt-solution can be similarly electrolyzed or decomposed, which may be illustrated as follows: In a solution of sulfate of copper the positive pole will attract sulfuric acid and oxygen; the negative, copper and hydrogen. In a chlorid-of-sodium solution, chlorin will go to the positive, and sodium to the negative, pole, etc.

4. *Test by Galvanoscope (or Milliammeter).*—If the two electrodes are brought in contact with each other, the needle will deflect toward the positive pole.

5. *Polarity distinguisher* is a simple and practical test. It is constructed on the Oersted principle, that the magnetic needle tends to assume a position at right angles to the direction of the electric current. This small instrument shows the positive pole

by the appearance of the red color in the fenestra as soon as the poles are held in contact with the instrument.

58. Non-conductors are chalk, fat, oil, rubber, dry gases, and a multiplicity of other substances. Success, therefore, depends on the organic quality, form, and composition of the neoplasm of the stricture. Blood and muscular tissues are good electrolytes; hence, strictures readily yield to the electrolytic treatment. Fibrous tissues are more or less decomposed by the current, and that in proportion to the elements which enter into their composition. If the parts to be acted on are devoid of water, the electrolytic action will be slow, because water or moisture is necessary and forms one of the real elements of successful decomposition. Chalk being a non-conductor, it follows that calcareous strictures, which are dry and brittle in their narrow caliber, will not yield well, if at all, to the action of the electrolysis.

Having become acquainted with the different properties of the poles, each of which possesses its own specific powers, it is evident, from the foregoing, that for the destruction of strictures, the negative pole must be selected.

59. The next important question that arises, and which is a valuable factor for successful treatment, is, What is the best material to be used on the negative pole? We should select hard metals, those that stand in no danger of being decomposed or easily oxidized; hence, platinum, gold, and silver are best, but lead, tin, or brass do well.

The specific action produced by electrolysis in the treatment of stricture has received different names. This diversified nomenclature has produced considerable misunderstanding, and time has done little to remove the confusion and obscurity in which the action of electrolysis is still involved. Dutrieux calls it electrochemical cauterization. Dittel names it a chemical galvanocaustic. It seems that all who have written and experimented on the subject mean the same thing, but express it differently. This diversity in the nomenclature has provoked the criticism of the editor of that special department in Virchow's "Yahresbericht." Dutrieux, he says, depends for

the action of electrolysis on the caustic effects of the negative pole, which leaves a soft and less retractile cicatrix, and wonders that Newman relies on chemical absorption as an effect of the electrolytic action.

That the same thing is meant, is evident from the previous statement, as well as from the description of the modus operandi by Mallez and Tripier, who lay great stress, and rely on the chemical and not on the caustic effect that would result from the application of the positive pole or the approximation of the two poles. With such a definition, which is taken from Mallez and Tripier, why the French surgeons call the action "*par la galvano-caustique chimique*" cannot be understood.

60. Next, the term *absorption* must be defined, as some may object to it as not definite enough, or understanding that it pertains only to the action of lacteals. Webster's definition of absorption is as follows: "The process or act of being made passively to disappear in some other substance through molecular or other invisible means, as the absorption of light, heat, electricity, etc.," and such is the action exactly, as we will see hereafter.

The negative pole acts as a caustic alkali. If increased tension is used, it will destroy tissue; but mildly applied, it acts as a chemical absorbent on the altered tissue and restores the part to its normal condition. No one would think of curing a stricture by cauterization. The history of that treatment in uterine diseases has left too many painful reminiscences. The gynecologists loudly protest against a treatment that has proved so mischievous and unfortunate in uterine diseases, and this applies equally well to attempts to follow it in cases of stricture of the urethra.

STRICTURES OF THE URETHRA

61. The positive statement is here made that these strictures will be radically cured by electrolysis, which removes the pathological tissue in every instance. As proof of this statement the following statistics are introduced. We have successfully used this method of electrolysis in the treatment of urethral strictures

in more than 2,000 cases, which is not a large number for 30 years' active service, and would average not more than five cases per month. Eight years ago we published a compilation of 1,755 successful cases in the practice of fifty-four different operators,* mentioning their names and favorable opinions of the said method. In the same number of the journal in which this was published appeared an editorial from which the following is quoted: "The statistics accumulated by Doctor Newman, if all were reported, would cover a list of over 2,000 cases of urethral stricture treated by the electric method. In the face of such a mass of positive evidence, one is tempted to explain the dissent existing by the application of the personal equation. Still, every one has the right of opinion and free expression; and if the opponents of this method desire it, the columns of the Times and Register are equally at their service." No statements of dissent have been sent; the writer gave documentary evidence for everything stated, which was investigated and found correct by an impartial committee of the American Electrotherapeutic Association, who reported accordingly. Many of these patients have been kept under observation, have been reexamined after years, and no relapse followed. Today, after an interval of 25 years, most of these can be found stating that they have kept well without having had a relapse. In a few instances a patient returned after years with a new ailment, mostly of the prostate or bladder, but never had a stricture in the same place, which had been cured by electrolysis. During these years we have never lost a patient by death while under treatment for a stricture.

Death, however, followed in every instance known to us when a patient gave up the electrolytic treatment by us for the sake of undergoing a urethrotomy, which in these cases was never performed by us, but by most skilful surgeons of unquestionable ability, who did the work well. The operators cannot be blamed for the fatal result, but we must accuse the system. The causes of death in these cases were mostly sepsis and uremia, after a secondary hemorrhage. Cystitis and suppression of

* Times and Register, April 3, 1893.

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urine had preceded. Nowadays the strongest advocates of urethrotomy will not promise a cure, and patients so operated on will remain patients until the end of their lives. Any incision either heals by first intention, which makes the caliber of the same size as before the operation, or if the divided surfaces are kept apart a cicatrix by granulation is the consequence, which is worse than it was before the cutting. It is useless to give the details of these cases, which were received only by courtesy of the operating surgeon, and only refer to cases known to us. Other methods may cure certain strictures that are simply contractions within the urethra, but it has not been proved that fibrous pathological conditions of induration, invading tissues around and outside the urethra, and even the cavernous and spongy bodies can be removed by cutting, divulsion, or dilatation.

62. Definition of Urethral Stricture.—Writers have described different kinds of stricture, and all have spoken of a spasmodic stricture, which we consider a most unfortunate mistake. "*Where there is failure to pass a sound through the urethra, it can only indicate either unskilful manipulation, organic stricture, or a tortuous urethra from prostatic enlargement.*"* A spasm is a temporary action, dependent on other causes, and should not be called a stricture, besides the successful treatment must be different. For our purpose we can acknowledge only an organic stricture, which is a permanent stricture dependent on pathological conditions. Therefore, the definition of an organic stricture should be a permanent narrowing of the caliber of the normal urethra, which either exists in the urethra itself or in the tissues surrounding the canal. In most cases, pathological formations of fibroid plastic material accumulate, grow, and, by taking a space for themselves, crowd against the canal, thereby diminishing its caliber. Sometimes we find these submucous infiltrations in all parts of the penis, except in the cutaneous covering; they may cause a very long stricture or in different parts of the urethra appear as multiple strictures.

* R. W. Stewart, M. D., M. R. C. S., "The Diseases of the Male Urethra."

Complications may add violent spasm to an organic stricture, and then need a different treatment for either. Such strictures always begin with a thickening of the mucous lining of the urethra, which is the first stage of the disease.

63. Etiology.—The cause is almost always an inflammation. This may occur from any obstruction—traumatism—but as a rule it results from the long continued discharge, the consequence of a chronic urethritis. During the course of an urethritis, stricture may be caused by too strong injections, the use of instruments, or even catheterization. However, all strictures are the consequence of an inflammation.

64. Symptomatology.—As a rule there is a general malaise, a gleety discharge, frequent micturition, uneasiness, hesitation, delay, pain, and scalding on voiding urine, the stream of urine is getting smaller by degrees, later on it has less force, and may only dribble away. The prostate gland may become involved; also a vesical catarrh causing an alkaline urine, which gets cloudy, and by degrees becomes loaded with phosphates, ropy mucous, pus, and blood. The consequences in time are more dangerous, the bladder dilates, gets paralyzed, stagnant urine accumulates, fills the ureters, affects the kidneys, and finally the retention of urine may end fatally.

65. Diagnosis. — Patients go to the physician not for the treatment of the stricture, but because they are troubled with unpleasant symptoms that should cause the doctor to suspect the disease. The diagnosis, however, can only be made correctly by a careful examination with good instruments. The differential diagnosis is nevertheless important, and the following maladies have particularly to be considered and excluded: granular urethritis, chancroids, syphilis, gouty concretions, spasm, prostatitis, vesical catarrh, neuralgia, calculus, tumors, abscesses, hemorrhoids, fissures, and other rectal diseases. A small stream, for instance, does not always indicate a stricture, particularly if it appears suddenly and is temporary. Twenty-five per cent. of cases that have been sent to us by good practitioners for treatment as strictures proved, on examination, to

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62. Definiti…
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time: Five cells produced distinct effects in 5 seconds; ten cells, in 2 seconds; twenty cells, in 1 second.

When all forty cells were used, a boiling commenced immediately, smoke arose, a hissing sound was heard, a froth was formed around the point of the bougie, and a hole was produced in a short time. The effect produced by the two poles differed widely, and could be observed as follows: The positive pole had caused a destruction of parts in an uneven, ragged manner; the surface looked like an ugly sore of a yellow color, mixed with gray at the margin. It stimulated somewhat the ulceration of a chancroid. At the negative pole was seen only points, small in circumference, of a whitish color; even a little of the pinkish hue was left, and there was no destruction of tissue. A smooth surface was presented, but the normal lubricating moisture had given way to a dry state. This dryness at the negative pole, and the destruction of tissue with an ulcerating surface at the positive pole, gave rise to a partial phymosis afterward.

EXPERIMENT 2.—A dog was prepared as in the first experiment. The positive pole, by means of a forceps, firmly held the mucous lining of the penis far back, where the prostate lies. A bougie, of an egg-shaped form, connected with the negative pole was introduced into the urethra, 2½ inches deep. Then the electrolysis was used with all forty cells at once, and continued for 20 seconds. A boiling was distinctly seen and heard around the negative pole; at the positive pole a destruction of tissues and an ugly sore was produced exactly as in the first experiment. The dog felt sick, had no appetite, and could not urinate for 2 days. The malaise was increased by the sore and the addition of the destruction at the positive pole, again caused an inflammation and phymosis. After 2 days the obstacle in the urethra gave way at once, the plug formed by the electrolysis popped out, the dog passed water mixed with blood, and it finally made a good recovery.

Many other experiments have been made, and all prove the correctness of the theory explained before. The last experiment was only made to ascertain the tolerance of a strong current as a therapeutical agent. This experience has proved

conclusively that the means of curing strictures consists mainly in using weak currents. Mischief may be done by strong currents, which destroy tissue rapidly instead of causing chemical decomposition.

EXAMINATION OF STRICTURES

68. When the narrowed caliber of the urethra first attracts the attention of the patient, the physician must at the first examination decide if the cause of it depends on an inflammation of the mucous lining or on the new plastic formations around the urethra. In the first instance, the caliber of the urethra is narrowed by the product of inflammation thrown out by exudation internal to the mucous lining. The case may be complicated by the presence of more or less granulations, whereas in the latter case the caliber is lost by the pressure on the altered parts and heteroplasia of the deeper submucous tissues. The knowledge of this pathological condition is a fact of much value for the intelligent and successful application of electrolysis; if this is understood, it necessarily follows that both the current-strength and the duration of its application should be increased in order to penetrate the tissues to produce absorption. Certain facts should be inquired into concerning the history of the case, such as the general condition of the patient, former diseases, inherited diatheses, peculiar dyscrasia, complications, etc. Having ascertained this history, and noted carefully all its details, the investigation is still further continued by direct examination of the stricture in the following manner: (1) By instruments and digital transmission; (2) by exact measurement; (3) by ocular inspection.

69. Examination by Instruments and Digital Transmission.—The exploring instruments transmit to the fingers certain sensations, which experience soon classifies, and which culminate in a highly tactile expertness. The best instrument for this preliminary exploration is the whalebone bougie à boule, which has a small olive-shaped bulb and a slender neck that adds to its flexibility without losing a certain stiffness. Such an exploring instrument gives, from its peculiar shape, a delicacy of touch not to be obtained

from any other known instrument. It defines with professional certainty the nature of the stricture, and the progress of altered tissue can be ascertained and defined with a comparatively small experience, and with great certainty.

According to the sensation transmitted to the fingers, the progress of the stricture can be ascertained and four stages recognized as follows: The first stage conveys a feeling of velvet or velveteen; the second, paper; the third, parchment; and the fourth, cartilage. In the normal state of the urethra, the bougie glides with comparative ease over its moist mucous lining. The skilled finger will readily detect any alteration or deviation; its comparative and relative severity and the slightest encroachment on its normal standard will be revealed. The velvet touch represents a slight alteration only; the paper touch represents the inflammatory stage; the parchment touch represents fibrous tissue; the cartilage touch represents calcareous, or callous, deposit, and signifies the worst form of stricture.

By the use of the olive-shaped whalebone bougie, the defects or any abnormal condition of the urethra along its whole tract is soon detected. The instant the bougie enters the stricture, a peculiar feeling is manifest to the fingers of the operator; its penetration is announced with a great degree of certainty; there is a peculiar grasp—"a taking hold"—which is distinctly felt on entering or withdrawing the bougie.

70. Examination by Measurement.—In order to ascertain with certainty the exact locality, lengths, size, etc. of the stricture, we introduce into the urethra a sound as large as the meatus will admit. By this maneuver we ascertain at the beginning of our manipulation the normal caliber of the urethra. The sound is then pushed gently forward until we reach the stricture. That being accomplished, we carefully note, in inches, by actual measurement, the distance of the first stricture from the meatus. Next, we ascertain how large a sound the stricture will allow to pass; at the same time an attempt is made to ascertain the length of the stricture. Having discovered the available sound, the exploration is continued until the whole of the stricture has come under notice. If any more

strictures are discovered during the investigation, they are measured in the same manner as the first. A note of this topography is made and carefully recorded, because in all future operations the perfect knowledge of the localities of the impediments is of extreme importance for their proper treatment.

The measurement of a stricture can also be made with a urethrometer. Newman's urethrometer is curved and can be introduced into the bladder. Another instrument for measurement is the urethrograph, invented by Dr. R. W. Stewart, which gives an exact drawing of the urethral canal on paper like the sphygmograph.

71. Examination by Ocular Inspection.—Ocular inspection by the urethroscope will reveal important facts, such as form and color, character, or any complication by which the case may be surrounded. The form of stricture is not of necessity always annular; the contraction may vary and assume many different forms. Thus, there may be irregular slits of different sizes, and in all directions, oval, round, square, triangular, and serrated — in fact of infinite variety.

A fact of vast importance, and an extremely valuable factor in the diagnosis, is the following: When the tube of the endoscope is withdrawn from the urethra after an exploration, if the stricture is sensibly indurated and especially if it be a slight one, the canal closes immediately behind it with great abruptness, a circumstance which is in striking contrast with the gradual closing observed on the withdrawal of the instrument from a healthy urethra. After a careful and minute examination is made and the state, size, etc. of the urethra duly noted, a plan of action and future treatment in accordance with the principles previously enunciated is concluded on and immediately carried out. In manipulations in the urethra or bladder, all surgical precautions, it is needless to say, should be scrupulously observed.

DIFFERENCE OF METHODS

72. There is a marked difference in the methods practiced with regard to the battery used, their elements, the fluids, the correct electrodes, the pole as the working electrode, the strength

of the current, and the duration and the interval of the séances. Then the intended effect as a system has to be considered, whether an electrolytic or a cautery action is wanted, or a combination of the two. From experiments made, observations of other operators, and a large personal experience, we have come to a conclusion, and therefore recommend only one procedure, as follows: Electrolytic action, by mild currents, from batteries with small cells containing weak fluid. This current produces gradual chemical absorption when properly constructed electrodes are skilfully manipulated, as will be described hereafter.

73. The Armamentarium.—This consists of a good galvanic battery, with conducting-cords, one or two handle electrodes as the indifferent pole, a few binding-screws, one milliamperemeter and rheostat, a bougie à boule, filiform guides, and four sets of Newman's urethral electrodes. These instruments suffice for our treatment, and the sound electrodes may be procured by installments as required. As auxiliary instruments, may be mentioned an urethrometer and an urethroscope.

74. The Galvanic Battery.—This must be selected for the production of mild electrolysis. A battery presenting a large surface and big cells is unsuitable, as it will cauterize more rapidly and more intensely than a caustic. By using a superabundance of electric current, induced by a large surface, with the hope of augmenting its sphere of action, too much inflammation is induced, destruction of the surrounding tissues takes place, suppuration supervenes, and the disease is thus aggravated. The current should never be strong enough in its action to lead to destruction of tissue; it should be confined to an effort to restore the affected parts to their normal condition.

In its application, the current of proper strength should be confined solely to the diseased locality. This is not always easy to accomplish with the batteries at command, and some failures on record may be mainly due to their defects; one of the most important is the want of thoroughly controlling the strength of the electric current. In the selection of the battery, the following points are important: (1) The tension of the

current must be augmented gradually cell by cell, without any interruption or shaking of the current, and the patient will hardly perceive the increase of tension that can be used. (2) The quantity of electricity must be reduced to a point sufficient to produce the most intense action on a very limited surface. (3) The cells must be small and the surface of the elements in proportion to the cells in order to absorb only and not to destroy tissues or cauterize. (4) Shocks, interruptions, and pain to the patient must be avoided. The fluid used must not be too strong,

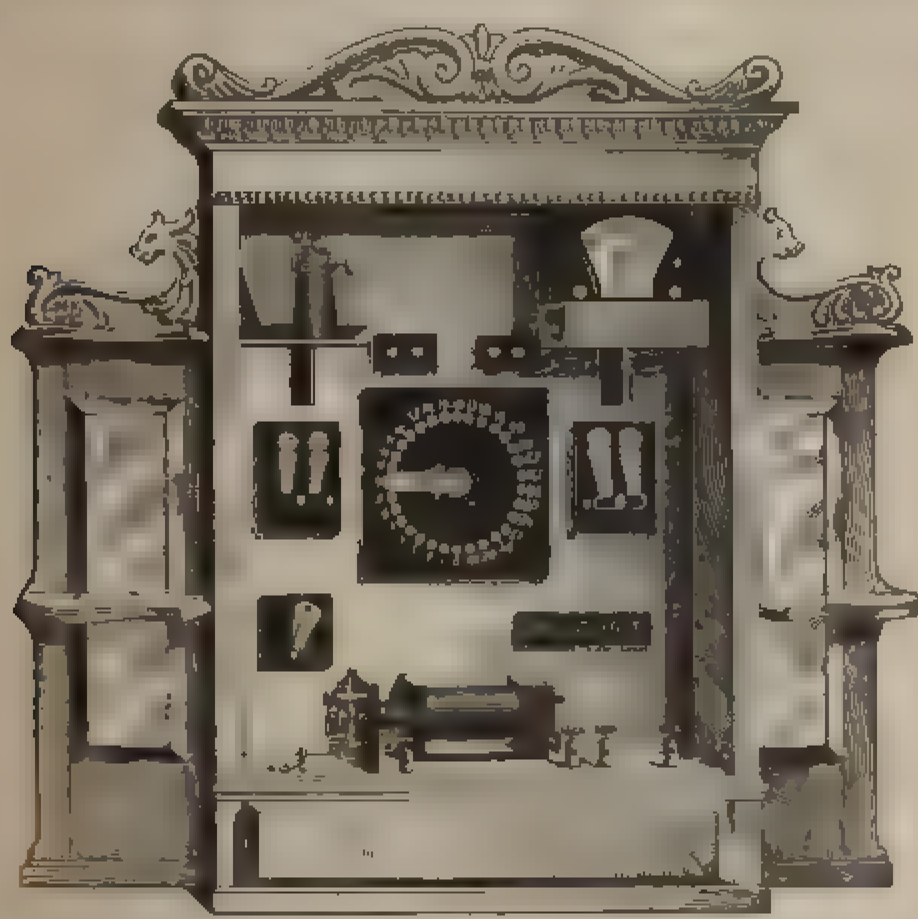

FIG 18
Wall Cabinet

but more diluted than ordinarily used. Any good instrument that has the described qualities can be used as a portable battery. We have constructed a 20-cell battery, which has already been described. In the office, a *cabinet*, Fig 18, is very serviceable. We have cells in the basement and the dial in the office as a wall-cabinet The latter has a pin for each of the forty-four cells, a current-changer, an interrupter, and the upper part is an ohmmeter. Below the interrupter are the binding-posts

for the two poles. On the left side are the switches; the one on the left is for the constant current, the second is for the interrupter, and the third connects the galvanic current with the milliammeter, which is placed on the top of the cabinet, and the scale of the milliammeter is read by reflection of a mirror. There is an independent set of cells with extra binding for other purposes.

75. Bougie à Boule.—This is the best exploring instrument that transmits to the finger certain sensations, which experience soon classifies, and which culminate in a highly tactile expertness. This instrument, Fig. 19, is made of whale-

FIG. 19
Bougie à Boule

bone, has a small olive-shaped head and slender neck, which adds to its flexibility. It is used to explore the urethra and find the number, nature, and size of strictures—the real topography.

76. Filiform guides are used to prevent false passages, over which the tunneled electrodes run with perfect safety.

FIG. 20
Filiform Guide

When the passage is very small and tortuous, the filiform, Fig. 20, by its flexibility, will adapt itself to the urethra and can be introduced into the bladder. This instrument must be managed with care, so that it does not turn on itself; it must be without a blemish or bend; the end must be perfect and not split, avoiding the danger of the electrode running into the divided parts and thereby being arrested. Any spasm of the neck of the bladder may prevent the entrance of the filiform into that viscus.

ELECTRODES

77. Electrodes are the most important feature for the treatment of urethral strictures. After many trials and experiments the following conclusion has been reached: Sounds (electrodes)

for the correct exploration of the urethra must be either entirely flexible, or stiff and unyielding. To the first class belong Nelaton's and Jaques's, which adapt themselves to the curves and inequalities of the urethra. These may answer for certain cases, but are not applicable for electrolysis as a rule. The type of the second class of explorers is the steel sound. The operator has it in his power to guide the sound where he pleases; it will not diverge from the course it is directed in; it is firm, never yielding. If the sound makes a false passage, the operator is held and made responsible. It is best to have a short curve for the guidance of the operator's hand. The old fashioned large curves were mistakes, and did mischief.

The surface of the electrodes must be smooth and well insulated, and without any inequalities. The only points not insulated and acting as conductors are the terminals, to one of which the conducting-cord from the battery is attached. The other terminal is acorn-shaped, or olive-shaped, for passage through the strictured urethra. A conical end is objectionable and would spoil the operation. For instance, if the instrument is a No. 10 and its conical end tapered equal to a No. 7, the electrolysis naturally cannot enlarge the stricture to a caliber larger than No. 7. When the conical end has passed and is free, the thicker part of the instrument hangs grasped by the constricted part of the urethra and cannot follow into the place nor push its extremity; or, in other words, the No. 10 cannot occupy a space of size of No. 7. As the only factor of reliance in this treatment is the electric power of absorption and not force, it is evident that the egg-shaped bulb answers best.

The length of this bulb extremity is in proportion to the size of the instrument; for a No. 11 French scale, the end is $\frac{3}{16}$ inch, for a No. 21 French, $\frac{3}{8}$ inch, etc. We have devised four different electrodes, which are known as *Newman's electrodes.*

NEWMAN'S ELECTRODES

78. Egg-Shaped Electrode.—The regular electrodes for all ordinary cases have a short curve and an egg-shaped, Fig. 21, metallic bulb at the working end, while at the other end there is

a round wire rod for the binding-screw of the negative pole of the battery. These are the only parts not insulated. The rest of the electrode must be well insulated, smooth, and without inequalities. A conical bulb is objectionable in most cases, as we depend on the electrolytic power of absorption, not on

FIG. 21

Egg-Shaped Electrode

force. The set consists of Nos. 11, 14, 17, 18, 20, 21, 23, 25, 28 of the French scale.

79. The Acorn Set.—These are for use in the first 6 inches of the urethra in certain cases, and consist of Nos. 15, 17, 20, 22, 25, 27, French. They are without a curve, short, and the bulb is acorn-shaped, Fig. 22. Sometimes it is desirable to gain ground by entering the contraction first with the point of the electrode, in order to follow easier with the larger part of the acorn; here, this form will do good work. The action of the electrolysis depends on the largest diameter of the bulb in these cases, and does most service on the withdrawal of the electrode, when the operator feels best how much work should be done. It is also used when the stricture is near the meatus.

FIG. 22

Acorn-Shaped Electrode

80. The Tunneled Electrode.—These are in Nos. 9, 11, 14, 17, 20, 21, French. They are very important for bad, tortuous strictures, and are to be used only by the expert operator. The curve is shorter and the egg-shaped bulb tunneled, so that it may be introduced over a filiform guide, Fig. 23. When the strictures are tortuous, these electrodes are safer, and false passages are impossible.

81. The Combination Electrode.—This is a tunneled electrode combined with a catheter, Fig. 24. When a very tight stricture is complicated with retention of urine, the indications are to remove the obstruction and draw off the urine with the same instrument, as the parts are too sensitive to tolerate the

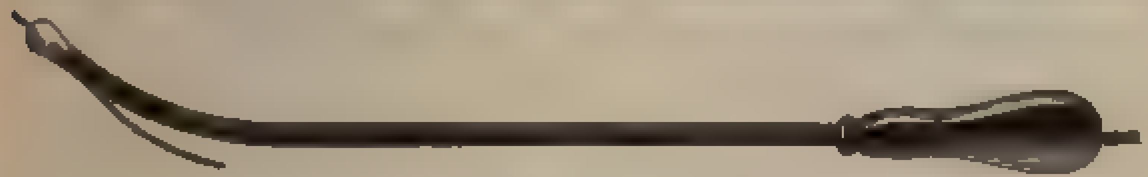

FIG. 23
Tunneled Electrode

introduction of two instruments in succession. The patient may also be benefited by washing out the bladder, all of which can be done with one introduction of this instrument, in which case some small quantity of water must be left in the bladder.

82. The bulbs of all the electrodes are just as large as the size they represent, not conical at the end as are the sounds usually sold. This makes a difference of from six to eight numbers between Newman electrodes and the shop instrument in which the number is expressed by the size at the shaft. The length of all electrodes is 8 inches from the bulb to the handle,

FIG. 24
Combination Electrode

and in almost all cases the bulb will be in the bladder after the instrument has been passed to the handle.

83. Difference in Sizes Between Newman's Electrodes and Sounds.—Attention may be called here to the apparent difference of the sizes between Newman's electrodes and usual sounds as sold by instrument-makers. The diagrams here presented are made from measurements of instruments in actual use.

Fig. 25 (*a*) and (*b*) represents the ordinary steel sounds, which are conical at the end, and the number is expressed by the size of the largest part of the stem, making a real difference of from six to eight numbers in different parts of the instrument. Fig. 25 (*c*) and (*d*) represents Newman's electrodes, which have their full size at the bulb end, as numbered. It will be seen at a glance that in the steel sounds a No. 38 is, at its conical end, only a No. 29, this tapering end making a difference of four and nine numbers, respectively. Therefore, the No. 32—French scale—Newman's electrode is as large at its end as the No. 46 steel sound. Hence, the diversity of opinion referred to is, in a great measure, explained by these diagrams, especially in relation to the result of treatment by electrolysis.

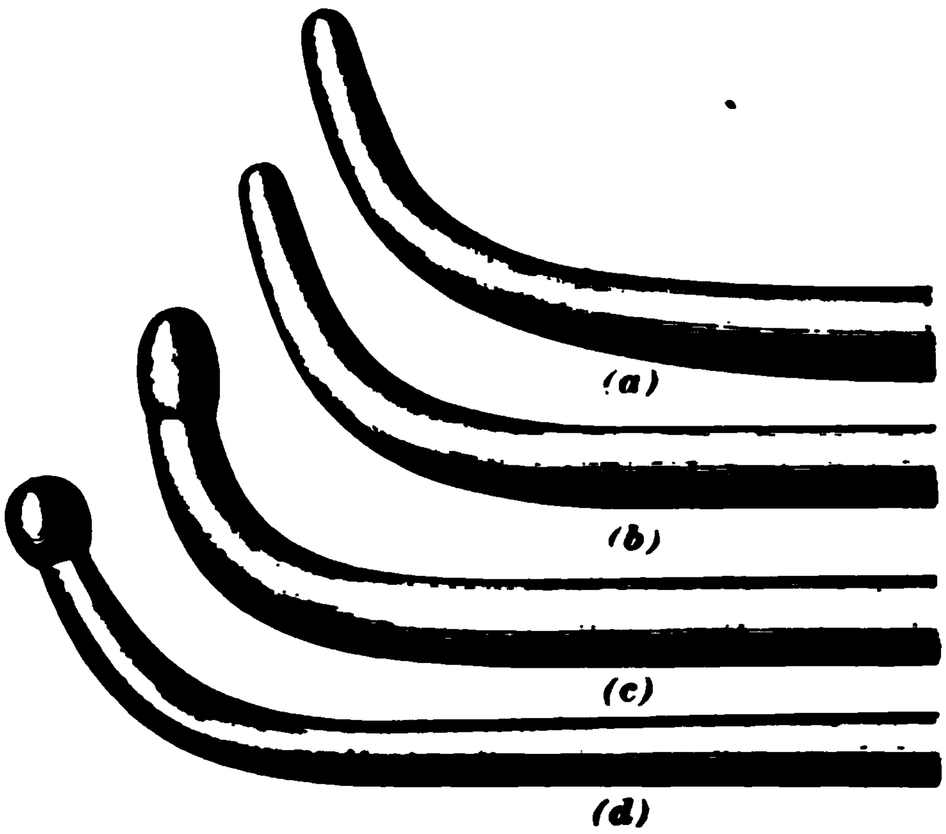

FIG. 25

MODUS OPERANDI

84. The object is to produce the solvent action of the alkalis and the disintegrating effects of diffused hydrogen. The art of applying electrolysis successfully consists in: (1) using the correct strength of the electric current; (2) applying the respective poles in the right place; (3) selecting the size, shape, and material of the electrode; (4) regulating the duration and intervals of séances; (5) avoiding any hemorrhage by adjusting the current and careful manipulations.

85. Electrolysis applied with a mild current will cause absorption only—a galvanic chemical absorption—while a strong current will burn, cauterize, or even destroy tissues.

Therefore, the operator must know what effect he wishes to produce, and graduate the strength of his current accordingly. The management of the operation must be such that every possible mishap is anticipated and prevented.

The diagnosis having been made, the stricture examined and measured with the bougie à boule (as previously explained), the history taken, the topography of the urethra well ascertained, and a plan made for the treatment and operation, a full knowledge is attained of what is intended to be accomplished. It is not advisable to operate on the same day; it is better to have one day intervene between the preliminary examination and the operation. Genito-urinary surgery is generally applied too severely, and often causes new inflammation instead of allaying it. It is also well to try the patient's susceptibility to the galvanic current, and assure him that he has nothing to fear from a weak current of a galvanic battery, as most people are not familiar with other effects than shocks. Much is gained if the patient comes to the operation fresh in mind and body, without any nervous depression.

86. The posture that the patient should assume during the operation is a matter of slight importance; according to his convenience he may stand, sit, or lie on his back with his shoulders elevated and his knees drawn up. Anesthetics are not used, for no pain should be caused, and the patient should be conscious, so that he can express his sensations. In exceptional cases of great nervous irritability, an injection of cocain —a 2- or 4-per-cent. solution—or any anodyne, may be used. It is still better to have the patient himself insert a rectal suppository 1 hour before the operation. Such a suppository may be composed of extract of belladonna, $\frac{1}{4}$ to $\frac{1}{2}$ grain; aqueous extract of opium, 1 grain, with a vehicle of gelatin or cocoa-butter. These anodynes are only for irritable, nervous patients, otherwise they are not necessary, as the operation should not cause any pain. All preparations must have been made before operating. The galvanic battery must have been previously tested in all its connections, so as to ascertain without a doubt that the poles have been marked correctly by the

manufacturer. The negative metal electrode must be warmed and lubricated with glycerin, and the other end connected by a binding-screw with the cord of the negative pole of the battery. The milliammeter must be well connected between the battery and the patient with modern appliances. It is of the greatest importance to fulfil all these details deliberately, carefully, and with scrupulous minuteness, in order to secure success. Antiseptic precaution must be observed particularly with the instruments to be employed.

87. For ordinary strictures the rule is to select an electrode that is three numbers larger than the size of the stricture, French scale. For very resilient strictures, it may be necessary to take an electrode one or two numbers larger. However, there are exceptions, which are governed by indications. When all preliminary arrangements have been made, the electrode is selected, lubricated with glycerin, which is a conductor, and then introduced into the urethra until the bulb is arrested by the stricture. It is also well if a mark has been made on the stem of the electrode, to indicate the distance of the stricture from the meatus, thereby making certain when the bulb end has reached the beginning of the stricture according to the measurements previously made. The positive electrode, wet with either hot water or salt-water, and connected with the positive pole of the battery, is to be held firmly against the patient's skin, either in the palm of the hand, the abdomen, the thigh, or some other part, to complete the circuit. At this stage of the procedure, it is well to observe that the positive pole touches only the cuticle of the patient, and not any metal. Rings or other jewelry will burn and must not come in contact with the circuit. While both poles are held in this manner, the current should be increased from zero until the patient feels a warm and slightly pricking sensation. This increase is made slowly, one cell at a time. At the same time the current is measured by the milliammeter, and in many cases 3 or 4 milliamperes will suffice.

The operator must keep the bougie steady against the stricture, and he will soon find that absorption is taking place,

that the stricture yields, enlarges, and the instrument slowly advances and passes the obstruction. At times it will fairly jump through the stricture. If there are more strictures than one, the bougie should be guided in the same way until it enters the bladder. Then the electrode is to be withdrawn slowly, stopping at each stricture, until the electrolysis has enlarged the caliber of the urethra sufficiently for an easy passing of the electrode used, which has to be guided and withdrawn, until the first stricture has been repassed, when the current is again to be reduced slowly, cell by cell, to zero; and then and not until then is the electrode to be removed. During the whole operation the electrode must be held loosely and gently in its place against the obstruction, any pressure or force being avoided. The bougie will take care of itself, doing its work by the electrolytic action of the current. It is best to guide the electrode with only the thumb and first finger; sometimes the second finger may be added. All the fingers of the whole hand should never be used. Gentleness must be exercised to the greatest degree, as the use of any force will prevent the action of the electrolysis and only act as any ordinary dilatation. A séance may last from 5 to 20 minutes, and if the electrode has not passed the stricture in that time, it is often better to discontinue than to unduly tax the patient or cause an irritation. The operator must now see that the battery is disconnected and the electrode well cleansed.

88. Each pin in the circle of the dial of the battery represents one cell, and the selector must be placed exactly on the pin and not on two pins, which would make a short-circuit of these two cells, or may make the galvanic current unsteady. No oil should be used for lubricating the electrode, as all oils are *non-conductors.* The use of vaseline is also dangerous, as it may enter the bladder, cake, and become the nucleus for a vesical calculus.

The operator, experienced in this kind of manipulation, is always made aware, by digital transmission, of the location of his electrode and the nature of the pathological tissue when he comes in contact with a stricture. The current should never be allowed to become so strong that it causes pain. Pain

is a sign that either the parts are in an inflammatory condition or that the current is too strong, and may cauterize instead of absorb. As a rule, on withdrawing the bougie electrode, there will be around the tip a frothy, white mass, which bears a resemblance to coagulated albumen. This is the hydrogen freed from the decomposed tissues, and if this mass has yellow streaks intermingled with it, it may be a part of the stricture.

At each operation only one instrument should be introduced into the urethra, and never two or more. After the operation, the patient must be left unmolested, no instrument used, and no sound, or catheter, introduced. Any instrumental interference will do harm and spoil the success.

SÉANCES

89. An interval of one week must be allowed before a repetition of the operation can be made, and even a longer time if indicated by pain or other symptoms. At each following séance a larger electrode is used, generally two numbers larger. Such treatment must be continued until the urethra has recovered and resumed its normal caliber, whatever this may be. As a rule, every patient may be well content, if his urethra admits a sound of No. 24 French. Generally, the treatment must be continued until the urethra has the normal caliber, unless circumstances contraindicate the attempt.

AFTER-EFFECTS

90. After-effects, like urethral fever, cystitis, etc., do not take place, but will follow if any instrumentation, like catheterization, is attempted after the electrolysis. This is another advantage of the electrolytic treatment over all others, and even Doctor Bumstead admits this in his excellent work, saying: "Either of the modes of treatment (of strictures) now described may be followed by rigors and other unpleasant symptoms, which are known as urethral fever, and sometimes terminate in speedy death."*

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*Bumstead, "Venereal Diseases," page 300.

91. The question is often asked, Is the result of the treatment an absorption or a dilatation? *Never—no dilatation!* It is a mistake to say that the action of electrolysis is a dilatation, or, as some author remarked, a modified dilatation. It is no dilatation at all, because the electrode is passed by simply holding and guiding it through the stricture. This is done by absorption and thereby causes an enlargement and restitution of the caliber. The absorption of the fibrous tissues goes on gradually, relieving the stricture and enlarging the caliber of the urethra until it is restored to its normal size.

We protest against electrolysis causing any dilatation, which is an entirely different process, in which some kind of force is always more or less necessary, and force in the electrolytic application is always a fault. Opponents sometimes say, "Perhaps it was a spasmodic stricture!" We assert positively that spasmodic action must be treated by the faradic current, and that galvanism makes the spasm worse. If galvanism cures a stricture, it is a proof that it was an organic stricture.

CURES AND RELAPSES

92. Reports of success have been in abundance—patients have been cured by electrolysis and have never had relapses and remained well. Some patients have been under observations for over 26 years without having had a day of sickness or any relapse. Have autopsies proved the absorption? Yes, they have. Many years ago Dr. C. C. Terry presented a specimen to the New York Pathological Society, which proved that electrolysis had restored the mucous lining of the urethra to a normal state. Our experience is that autopsies have confirmed his ante-mortem conclusions.

Statistics of successes of the electrolysis with no relapse have been reported in abundance, mostly verified by documentary evidence. Investigations of the reports of our statistics have been made. The final report in the "Transactions of the American Electrotherapeutic Association for 1893," page 40, was verbatim: "We have examined the records of Doctor Newman's cases and regard his conclusions as well sustained by the statistics, and as far as our experience in this line of work adds

further testimony, it is confirmatory of the value of the continuous currents in resolving a large class of urethral strictures, etc." This report is signed by Doctors A. H. Goelet, Wm. J. Morton, and W. J. Herdman. That under some circumstances some medical critics throw doubt on the correctness of the statistics, appears almost as a wilful libel.

RULES

93. The following rules, as a recapitulation, are a safe guide for the treatment of urethral strictures by electrolysis:

1. A good galvanic battery must be used, either portable or cabinet, having certain qualities for electrolysis.
2. The fluid for the battery should not be used too strong.
3. Auxiliary instruments are good to the expert, but not so necessary for the beginner. However, a milliammeter is imperative.
4. A carbon electrode is used for the positive pole. It must be covered with felt or absorbent cotton, moistened with hot water, and held firmly against the cutaneous surface of the patient's hand, thigh, or abdomen.
5. The negative pole must be used for the absorption of the stricture.
6. Electrode bougies are firm sounds insulated with a hard-baked mass of rubber; the point is an egg-shaped metal bulb, which is the acting part in contact with the stricture.
7. The curve of the bougie is short; large curves are mistakes.
8. The plates must be immersed in the fluid before the electrodes are placed on the patient, and raised again after the electrodes have been removed.
9. All operations must begin and end while the battery is at zero, increasing and decreasing the current slowly and gradually, one cell at a time, thus avoiding any shock to the patient.
10. Before operating, the susceptibility of the patient to the electric current should be ascertained.
11. The problem is to absorb the stricture, not to cauterize, burn, or destroy tissues.
12. Weak currents at long intervals.

13. In most cases a current from 2½ to 5 milliamperes will do the work, but it must be regulated according to the work to be done.

14. The séances should be at intervals of one week, not oftener.

15. The best position for the patient to assume during the operation is that which is most comfortable for himself and the operator. We prefer the erect posture, but the recumbent or others may be taken.

16. Anesthetics should be avoided.

17. Force should never be used. The bougie must be guided in the most gentle way, and the electric current alone must be allowed to do the work.

18. Two electrodes in succession should never be used during one séance.

19. All strictures are amenable to treatment by electrolysis.

20. Pain should never be inflicted by this operation. Therefore, it should not be done when the urethra is in an acute or even subacute inflammatory condition.

21. The electrode should not be greased with substances that are non-conductors and would insulate.

22. For ordinary stricture, the size of the electrode selected should be three numbers (French) larger than the stricture.

ADVANTAGES OF ELECTROLYSIS

94. The advantages of electrolysis are as follows: (1) Electrolysis is applicable to all strictures in any part of the urethra. (2) It will pass and enlarge any stricture when other instruments or the skill of surgeons fail, which has often been demonstrated. (3) It causes no pain or inconvenience. (4) It is devoid of danger. (5) It is not followed by hemorrhage, fever, or other unpleasant consequence. (6) It relieves at once. (7) The patient is not prevented from attending his daily work or business, and can earn his living while under treatment without restraint. (8) No relapse takes place, if once cured.

STATISTICS, SUMMARY

TABLE SHOWING REPORT OF CASES FROM 201 TO 300 OF OUR 300 CASES

Number	Patient's Initials, Residence, Date of First Visit	Age, Years	Cause, Duration, Complications of Stricture	No. of Strictures Found	Distance from Meatus, Inches	Size of Stricture, Fr. Scale No.	Treatment: How Many Séances	Treatment: Average Intervals, Days	Treatment: Time of	Sequel and Caliber of Urethra when Discharged, French Scale No.	Last Heard From After Treatment	Time After Discharge Without Relapse
201	M. G. F., N. Y. C., 1887, March 24	49	Continued urethritis, 7 yr. Impotence	4	2, 4, 5, 6	12	15	10	5 mo.	Urethra enlarged to No. 28	March 27, 1890	3 yr.
202	E. G. B., Albany, 1887, March 26	55	Strictures 20 yr., prostate enlarged	3	2½, 4½, 6½	18	8	14	4 mo.	Urethra enlarged to No. 32	March 30, 1892	5 yr.
203	J. W. R., Oregon, 1887, March 31	35	Urethritis, 15 yr., spinal irritation	3	3, 4½, 6½	11	4	5	4 wk.	Improved to No. 23, left for home	March, 1888	1 yr.
204	E. S. E., N. Y., 1887, May	32	Urethritis, 3 yr., bungling electrolysis, periurethral abscess	3	2, 4, 6	6	7	8	2 mo.	Improved to No. 17; very little progress. Withdrawn.	*	
205	C. C. W., Chicago, 1887, June 9	48	Urethritis, 8 yr., character unknown	3	5, 6, 7	18	2	8	†	In two séances, enlarged to No. 23	June, 1890; through family physician	3 yr.
206	S. H. H., N. Y. C., 1887, July	29	Prolonged urethritis, 2 yr., Urethrotomy	2	3, 5½	18	20	8	5 mo.	Urethra enlarged to No. 32, Fr.	Reexamined Jan. 8, 1889; well	2 yr.
207	W. G. C., Ulster Co., 1887, July 27	23	Strong injection, 3 yr.	4	4, 5, 6, 7	0	15	12	6 mo.	Urethra enlarged to No. 26, Fr., the limit of meatus	Heard from him and family physician, is well	4 yr.
208	W. M. H., St. Louis, 1887, Aug. 19	32	Long continued urethritis, gleet, 4 yr.	2	3, 4	17	7	9	2 mo.	Caliber enlarged to No. 28 Fr.	Reexamined with No. 28, Sept. 1888; well	1 yr.
209	G. R. B., N. Y. C., 1887, Aug. 24	40	Gleet, 3 yr.	3	3, 4, 6½	15	8	8	2 mo.	Enlarged to 26, limit of meatus. Well	June, 1892, well; no relapse	5 yr.
210	R. S. S., New Haven, 1887, Aug. 29	24	Prolonged urethritis, 1 yr.	3	3, 5, 6	17	6	14	3 mo.	Enlarged to 28. Normal caliber 28. Well	Reexamined Sept. 5, 1888	1 yr.
21ı	M. H. M., New Haven, 1887, Aug. 29	23	Urethritis, gleet, 2 yr.	2	5, 7	18	4	12	6 wk.	Enlarged to No. 25, Fr., size of meatus. Married and well	Reexamined Oct. 16, 1888; well	1 yr.

* Former injudicious electric treatment has injured the case. † Operated while in Chicago.

212	E. S. G., Tennessee, 1887, March 27	42	Prolonged urethritis, 10 yr.; prostatitis, cystitis	2	3, 5	23	8	10	3 mo.	No. 27 Fr. Well	Reexamined Aug. 11, 1891, well	5 yr.
213	W. D. C., N. Y. C., 1887, Oct. 2	58	Inflammation, traumatism, bladder overdistended, 5 yr.	2	5, 7	4	5	12	2 mo.	Improved; 14; gone west	Oct. 28, 1889; written that he felt great relief	2 yr.
214	J. C., New Orleans, 1887, Oct. 5	27	Strong injection; urethrotomy, 2 yr.	1	7	0	10	8	2½ mo.	Enlarged to 26; gone to N. Orleans; well	Not heard from.	
215	J. M. D., Indianapolis, 1887, Oct. 19	60	Not known; enlarged prostate, yr.	1	5	20	3	4	2 wk.	Improved to 26; content and gone home	Not heard from.	
216	D. T. H., Newark, 1886, Aug. 1	50	Balanitis; cicatrix after porotomy 8 mo.	1	Meatus	18	5	7	1 mo.	No. 27; well	Reexamined Feb., 1892; well	6 yr.
217	H. T., Brooklyn, 1887, Oct. 30	22	Strong injection, druggist's mistake; traumatism, 6 mo.	3	2, 4, 6	3	26	10	9 mo.	No. 21; improved; temporary, failure	Relapse, 1890	Failure.
218	T. B., Charleston, 1887, Nov. 15	24	Urethritis; urethrotomy, 6 yr.	2	6, 7	20	4	7	1 mo.	No. 28, well	Physician reports well, 1892	5 yr.
219	R. W. G., Bloomfield, N. J., 1888, Jan. 20	46	Strumous inflammation, ulcers, 2 yr.	1	4	7	5	6	1 mo.	Improved, 20; Dr. Wile continued treatment	Dr. Wile reports patient well, 1892	4 yr.
220	I. T. K., Blairsville, Pa., 1887, Nov. 16	37	Prolonged urethritis; orchitis, 11 yr.	1	4	17	6	7	1½ mo.	Enlarged to 26; well	Not heard from.	
221	C. D. B., N. Y. C., 1887, Nov. 28	47	Gleet, 20 yr.	2	5, 6½	12	7	8	2 mo.	Enlarged to 28; well	Not heard from.	
222	A. L. B., N. Y. C., 1887, Nov. 28	60	Traumatic rupture of urethra, 17 yr.	3	2½, 5½, 6½	20 16	7	*	3 mo.	Enlarged to 28; well	Reexamined twice, Nov. 1888	1 yr.
223	J. B., Philadelphia, 1887, Dec. 14	35	Traumatic bungling electrolysis, 7 yr.	1	7	0	13	*	4 mo.	Enlarged to 25; well	Reports well, by letter, 1890	2½ yr.
224	R. J., Colchester, Conn., 1887, Dec 14	50	Traumatic retention, cystitis, orchitis, 3 yr	1	7	17	2	14	2 wk.	Improved to 20; could not come again	July, 1888	6 mo.
225	G. A. S., N. Y. C., 1887, Dec 30	28	Gleet continuous, for 2 yr.	2	3, 5	17	6	8	2 mo.	Enlarged to 26, well	Reexamined Feb. 13, 1889	1 yr.
226	Dr. J. S. C., N. Y. C., 1888, Jan 3	47	Inflammation, urethrotomy, 10 yr	2	3, 5	21	8	7	2 mo.	Enlarged to 32; well and married	Reexamined 1892	4 yr.
227	A. D., Greenville, N. J., 1888, Feb. 3	49	Gleet, two urethrotomies, 10 yr.	2	2½, 5½	21	5	*	3 mo.	Enlarged to 30	Reexamined, March 14, 1890	2 yr.
228	J. D., N. Y. C., 1888, Feb. 6	46	Gleet, retention, urethrotomy, 17 yr.	2	4½, 5½	6	14	11	4 mo.	Improved, 27; patient was transferred and spirited away by a surgeon.		

* Irregular.

STATISTICS, SUMMARY—(*Continued*)

Number	Patient's Initials, Residence, Date of First Visit	Age - Years	Cause, Duration, Complications of Stricture	No. of Strictures Found	Distance from Meatus, Inches	Size of Stricture, Fr. Scale No.	Treatment: How Many Séances	Treatment: Average Intervals Days	Treatment: Time of	Sequel and Caliber of Urethra when Discharged, French Scale No.	Last Heard From After Treatment	Time After Discharge Without Relapse
229	F. S. B., Hackensack, N. J., 1888, Feb. 13	23	Urethritis, 1 yr.	1	5	17	6	14	3 mo.	Enlarged, 28; well	Reexamined Oct. 4, 1892	4½ yr.
230	J. G., Topeka, Kansas, 1888, Feb. 27	36	Urethritis, 2 yr.	2	2½, 5	18	2	8	1 wk.	Improved, 25	March, 1889, No. 25 passed	1 yr.
231	R. L. C., N. Y. C., 1880, March 4	35	Strong injections, 5 yr., nervous prostration and spasm	2	2½, 6½	*	12	*	4 mo.	Little improved to 17; patient absented himself	Intercurrent sickness; no material success, 1889	
232	G. B. C., Montreal, 1888, March 30	54	Traumatism, prostatitis, cystitis, urethrotomy, 7 yr.	3	2½, 2½, 6½	17	7	7	6 wk.	Enlarged to 28; is well	By family physician, 1891	3 yr.
233	A. J. S., Brooklyn, 1888, April 2	60	Unknown; cystitis, prostatitis, 10 yr.	1	3	20	5	7	1 mo.	Improved to 25; gone South	Not heard from.	
234	V. S. N., N. C., 1888, April 27	40	Traumatism, 10 yr.; urethrotomy	3	2½, 4½, 5½	15	3	6	1½ mo.	Enlarged to 25; gone home	By letter, 1891	3 yr.
235	C. H. H., N. Y., 1888, April 30	34	Prolonged gleet, 5 yr.	2	4, 5	11	6	6	1 mo.	Enlarged to 25; well	Reexamined Sept. 1892	4 yr.
236	G. T., N. Y. C., 1888, May 2	39	Gleet, spasm, 8 yr.	2	3½, 5	6	15	*		Enlarged to 28; well	Reexamined Jan. 1892, well; also 1890, 1891	4 yr.
237	C. S., N. Y. C., 1888, May 14	70	Inflammation, retention, enlarged prostate, 6 yr.	2	4½, 6½	17	6	10	2 mo.	Enlarged to 28; capacity of meatus; well	Reexamined Sept. 9, 1889	1½ yr.
238	G. L., Florida, 1888, May 18	26	Urethritis, epididymitis, 1½ yr.	2	4½, 5½	21	3	5	10 da.	Enlarged to 28; gone home	Not heard from.	
239	Dr. E. H., Brooklyn, 1888, May 21	48	Gleet, 8 yr.	2	3½, 5½	18	6	10	2 mo.	Enlarged to 28; well	Reexamined Dec. 17, 1890†.	
240	J. T. M., N. Y. C., 1888, May 19	52	Gleet, 12 yr., urethrotomy	3	3½, 5½, 7½	20		*		Enlarged to 25; well	Reexamined Feb. 1892	4 yr.
241	J. Z. A., Hackensack, 1888, May 26	24	Urethritis and inflammation, 9 mo.	2	3, 5	11	3	7	2 mo.	Enlarged to 25, capacity of meatus	Reexamined May 20, 1890	2 yr.

* Irregular. † Life insurance physician accepts and finds no stricture.

242	W. A. M., Redbank, 1888, June 19	40	Strong injections, 20 yr.	2	3, 5	9	11	6	3 mo.	Enlarged to 25	Saw patient off and on to 1892; is well	4 yr.
243	Dr. R. W., N. Y. C., 1888, July 21	31	Urethrotomy, no venereal disease, 1 yr.	1	3½	21	2		2 mo.	No. 25, passed easy	Saw patient often; is well	4 yr.
244	M. B. M., City, 1888, July 25	45	Urethritis, 10 yr.	1	3½	25	8	7	2 mo.	Enlarged to 30; is well	Reexamined July 19, 1889	1 yr.
245	E. B., N. Y. C., 1888, Aug. 14	28	Urethritis, 5 yr.	4	1½, 4, 4½, 5½	11	7	7	2 mo.	Enlarged to 25	Heard from off and on	3 yr.
246	J. H., Rahway, N. Y., 1888, Sept. 1	29	Urethritis, 2 yr.; urethral abscess; cystitis	1	5	15	6	7	1½ mo.	Enlarged to 28	Not heard from.	
247	A. C., N. Y. C., 1888, Nov. 3	34	Prolonged gleet, 8 yr.	1	4½	20	4	7	1 mo.	Enlarged, 25, patient left content	Not heard from.	
248	H. R. C., N. Y., 1888, Sept. 28	52	Inflammation, 30 yr.	3	3, 5, 7	0	6	7	1½ mo.	Much improved to 24; patient feels too well	Not heard from.	
249	T. M., N. Y. C., 1888, Sept. 25	26	Granular urethritis, gleet, 6 yr.	1				*		No. 27 passed size of meatus; is well	Reexamined May, 1891	2½ yr.
250	L. B., N. Y. C., 1888, Oct. 11	36	Urethrotomy, 9 yr.	1	3	25	6	15	3 mo.	No. 32 passed easy; is well	Reexamined Feb. 20, 1891	2½ yr.
251	Dr. A. W., Iowa, 1888, Oct. 30	37	Retention; cerebro-spinal meningitis; 12 yr	1	6½	20	4	7	1 mo.	No. 28 passed easy, is well	Not heard from.	
252	R. M. C., Texas, 1888, Nov 10	52	Urethritis, gleet, 32 yr.; urethrotomy	4	1½, 2½, 4, 6½	21	6	10	2 mo.	Enlarged to No. 30; well; gone home	Reexamined No. 30, May 14, 1891	2½ yr.
253	F. S., N. Y. C., 1888, Nov. 28	24	Urethritis, strong injections, 1½ yr.	2	1½, 5	11	7	†	4 mo.	Enlarged to No. 28;	Reexamined Oct. 1889	1 yr.
254	H. J., Brooklyn, 1888, Dec. 16	26	Gleet, 1 yr.	3	2½, 4, 5½	6		‡		Relapses in intervals; improved to 20	August, 1890, seen by Dr. Waite.	
255	K. B. M., Brooklyn, 1888, Dec. 22	39	Gleet, 16 yr.; urethrotomy	1	5½	17	5	7	1 mo.	Enlarged, No. 28	Not heard from.	
256	J. H. H., Troy, 1888, Dec. 29	39	Gleet, 16 yr., spasm of bladder	2	2½, 5	13	7	7	1½ mo.	Improved to 26. Meatus full capacity	Not heard from.	
257	C. A. P., N. Y. C., 1889, Jan. 4	30	Urethritis, caustics; 7 mo.; cicatrix of meatus	2	1, 5	6	5	6	1 mo.	Improved, 25; much as meatus will permit	Dr. McLaury reports him well, Sept. 1892	3½ yr.
258	G. P., West Indies, 1889, Jan. 15	33	Neglected inflammation; 3 years' congenital phymosis, with adhesions	2	4, 6½	14	4	5	1 mo.	Improved, 28; patient content, and went to sea	June, 1890, not worse	1 yr.

* Large caliber; treated also per endoscope; irregular. † Irregular. ‡ Irregular and long intervals.

STATISTICS, SUMMARY—(*Continued*)

Number	Patient's Initials, Residence, Date of First Visit	Age—Years	Cause, Duration, Complications of Stricture	No. of Strictures Found	Distance from Meatus, Inches	Size of Stricture, Fr. Scale No.	Treatment: How Many Séances	Treatment: Average Intervals, Days	Treatment: Time of	Sequel and Caliber of Urethra when Discharged, French Scale No.	Last Heard From After Treatment	Time After Discharge Without Relapse
259	J. W. S., Sprankles, Pa., 1889, Jan. 19	23	Gleet, orchitis, 4 yr.	1	6	11 28	3	10	1 mo.	Enlarged to No. 30; stricture cured	March, 1891, by letter	2 yr.
260	C. F. H., N. Y. C., 1889, Jan. 21	31	Gleet, caustics, 3 yr.	1	3	20	6	*	3 mo.	Enlarged to 28; capacity of meatus	Reexamined last, Feb. 17, 1890; well	1 yr.
261	W. E. N., City, 1889, Jan. 21	39	Gleet, urethrotomy, 9 yr.	2	3, 6	8	7	8	2 mo.	Improved, No. 25	Not heard from.	
262	A. C., City, 1889, Jan 27	44	Cystitis, prostatitis, no venereal disease, 9 mo.	3	2, 5, 8	20	6	12	2½ mo	Improved, No. 25	February, 1890	1 yr.
263	A. C. B., N. Y. C., 1889, Feb 3	27	Strong injection, 6 mo.	1	5	13	6	7	1½ mo.	Enlarged to No. 28	Reexamined June 14, 1890; well	1½ yr.
264	D. M. L., New Haven, 1889, Feb. 26	47	Not well known, 10 yr.	1	6	20	4	7	1 mo.	Enlarged to No. 25	Reexamined Feb. 18, 1892; well	3 yr.
265	J. W. F., Savannah, 1889, March 2	33	Neglected inflammation, 15 yr.	3	3, 5, 7	11	7	7	1½ mo.	Enlarged to No. 28	Gone South; not heard from.	
266	Dr. G. P. H., Galveston, 1889, March 2	36	Nervous disease, inflammation, 9 yr.	1	3½	20	4	5	1 mo.	Enlarged to No. 28, utmost capacity of meatus	Doctor wrote he had no relapse	1 yr.
267	Dr. F. B. G., N. Y. C., 1889, March 13	44	Organic cartilagenous stricture, 21 yr.	2	3, 5½	15, 0	16	8	4 mo.	Enlarged, No. 28; well	Doctor says he can pass 28 easy; June, 1890; well	1 yr.
268	G. M., N. Y. C., 1889, May 6	51	Gleet, 6 yr	1	5	18	7	9	2 mo.	Enlarged, No. 28; well	Reexamined April 16, 1891; well; No. 28	2 yr.
269	A. B., Bayonne, 1889, June 2	41	Neglected urethritis, 28 yr.; urethrotomy	3	3, 5, 6	5	10	*		Enlarged to 28; well and married	Family physician reports well, June, 1891	2 yr.
270	C. A. A., Boston, 1889, June 29	32	Traumatism, 5 yr.	2	2½, 5½	20	5	8	1½ mo.	Enlarged, No. 28; well	Reexamined Sept. 20, 1890; well; No. 28	2 yr.
271	B. R., Hackensack, 1889, June 22	24	No venereal disease. Cystitis, recent	1	4	4	5	7	1 mo.	Enlarged, No. 25	Heard from	½ yr.

* Irregular.

272	M. J. T., N. Y. C., 1889, Sept. 12	36	Strong injections, 6 yr., prostatitis	2	2, 4	14	11	*		Enlarged to No. 26, gone to St. Domingo	Reexamined July, 1891	1½ yr.
273	D. D. B., Montreal, 1889, Sept. 15	31	Traumatic, 15 yr.	2	3, 5½	6	4	6	½ mo.	Improved to No. 21; gone home	His physician reported well; Feb. 1891	1½ yr.
274	C. H., Croton, 1889, Sept. 20	47	Inflammation, cystitis, 10 yr.	3	2, 4, 5	11		†		Improved to No. 20	Sept. 28, 1892; reports well	3 yr.
275	E. L. T., N. Y. C., 1889, Sept. 28	33	Strong injections, 4 yr.	2	2, 4½	21	4	9	1 mo.	Enlarged to No. 26; is content	Reexamined, Jan., 1890. Seen Sept. 6, 1892; well	3 yr.
276	C. H., Brooklyn, 1889, Nov. 21	48	Strong injections, 30 yr.; urethrotomy	2	3, 4	28	4	7	1 mo.	Enlarged, No. 30; well	Reexamined April 2, 1892	2½ yr.
277	H. S., N. Y. C., 1889, Dec. 11	20	Gleet, 1½ yr.	1	4	21	4	14	2 mo.	Enlarged, No. 26; endoscope, etc.	Friends report him well; Nov., 1891	2 yr.
278	Dr. H. H., Brooklyn, 1889, Dec. 23	39	Gleet, 5 yr.	1	4½	22	6	7	2 mo.	Enlarged, No. 30; well	Reexamined March, 1891; well	1 yr.
279	J. R. P., 1890, Jan. 16	37	Strong injections, 4 yr.	2	2½, 6	21	7	9	2 mo	Enlarged, No. 28; well	Not heard from.	
280	E. B. D., Wisconsin, 1890, March 21	40	Urethritis, prostatitis; 2 yr.	2	1½, 4½	9	10	9	3 mo	Enlarged, No. 28; well	Reexamined April, 1891	1 yr.
281	N. P. S., Woodstock, 1890, March 29	36	Inflammatory discharges, 8 yr.	2	2½, 4½	‡	4	18	2½ mo.	Improved to No. 20; gone home	Prevented from coming again to N. Y.	
282	E. R., Dallas, Texas, 1890, May 12	50	Inflammations, uncertain cause, 20 yr.; prostatitis	1	6½	12	8	6	1½ mo.	Enlarged, No. 28; well	Not heard from.	
283	A. L. B., Bayonne, 1890, Sept.	48	Gleet, 8 yr., prostatitis	1	7½	17	7	8	2 mo.	Enlarged, No. 28, well	By family physician, March, 1892	1½ yr.
284	J. M. L., Watertown, 1890, Oct. 9	75	Inflammation, cystitis, retention, 15 yr.	2	4½, 5½	17	6	†	1 yr.	Much Improved; No. 26, left for home	By letter, well; 1892	1 yr.
285	L. S. W., City, 1890, Oct. 11	73	Gleet, retention, prostatic hypertrophy, 12 yr.	2	5, 6½	14	4	7	1 mo.	Much improved and prostate reduced	Not heard from.	
286	J. B., Texas, 1890, Jan. 8	24	Urethritis, urethral, fistula, 7 yr.	1	7	8	8	8	2½ mo	Enlarged, No. 28; well	Reexamined April 15, 1892	1 yr.
287	W. B. T., White Plains, 1891, Jan. 15	48	Urethritis, cystitis, 20 yr.	2	2, 7	17	12	*	4 mo.	Enlarged, No. 28; well	Reexamined May 18, 1892	1 yr.
288	W. H. S., N. Y. C., 1891, Jan. 22	47	Gout, urethritis, cystitis, 2 yr.	2	2½, 5½	17	11	*	5 mo.	Meatus won't admit larger than 24; well	Seen off and on; is well; March 1892	1 yr.
289	T. B., Roanoke, 1891, Feb. 7	41	Strong injections, 1 yr.	2	2½, 5½	22	8	5	2 wk.	Enlarged, No. 28	Written is well; Dec. 4; 1891	10 mo.

* Irregular. † Irregular and in long intervals. ‡ Filiform.

STATISTICS, SUMMARY—(*Continued*)

Number	Patient's Initials, Residence, Date of First Visit	Age—Years	Cause, Duration, Complications of Stricture	No. of Strictures Found	Distance from Meatus, Inches	Size of Stricture, Fr. Scale No.	Treatment: How Many Séances	Treatment: Average Intervals, Days	Treatment: Time of	Sequel and Caliber of Urethra When Discharged, French Scale No.	Last Heard From After Treatment	Time After Discharge Without Relapse
290	J. P., Katonah, 1891, Feb 25	29	Inflammation, cause uncertain, 6 mo	1	6¾	*	5	12	2 mo.	No. 28 passes easy	Reexamined Sept. 2, 1892	1½ yr.
291	F. H. S., 1891, March 9	46	Gleet continued 10 yr.	2	3, 5	17	8	7	2 mo.	No. 27, utmost capacity of meatus; well	Not heard from.	
292	H. N. P., N. Y. C., 1891, March 31	31	Gleet, 12 yr	2	2¾, 5¾	17	8	7	2 mo.	No. 26; well	Well; heard direct and indirect, July, 1892	1 yr.
293	J. L. M., Brooklyn, 1891, March 28	66	Rectal abscess, urethral fistula, strong injections, 25 yr	1–6		†			4 mo.	No. 26, the capacity of meatus	Reexamined May 8, 1892	1 yr.
294	W. H. B., 1891, April 18	33	Urethral abscess, 5 yr.	1	6½	18	8	7	½ mo.	Enlarged to No. 25, much improved	Not heard from.	
295	C. D. K., S. C., 1891, May 10	33	Traumatism by instruments, 6 yr.; urethrotomy	2	4, 6½	18	6	16	3 mo.	Enlarged, No. 28	Reexamined May 22, 1892	1 yr.
296	W. M. H., Chicago, 1891, May 12	80	Urethritis, 58 yr., urethrotomy; perineal section	3	3, 4½, 5½	14	8	7	½ mo.	Enlarged, 28; patient gone West, much improved	Not h[illegible] from.	
297	G. A. B., City, 1891, May 28	50	Gleet, 2 yr.	1	6	18	3	10	1 mo.	Improved, 26; feels well enough	Reexamined Dec. 16, 1891	7 mo.
298	W. K., City, 1891, June 2	45	Urethritis, 5 yr	3	3½, 4¾, 6	21	6	14	3 mo.	Enlarged, 28; endoscope treatment	Reports well; Dec., 1891	7 mo.
299	W. T. C., Trenton, 1891, June 19	30	Urethritis, gleet, 12 yr.	1	5½	21	3	6	½ mo.	Enlarged, 28; content	Not heard from.	
300	E. D. W., N. Y. C., 1891, Aug. 15	36	Gleet, 5 yr.	2	2¾, 5	17, 15	12	‡	6 mo.	Enlarged, 26; well	Saw patient who is well, Feb., 1892	6 mo.

* Large caliber. † Calcareous; irregular ‡ Irregular

REMARKS ON THREE HUNDRED CASES

95. In the selection of each series is a little difference. The first hundred cases was reported to the American Medical Association, in Cleveland, 1893.* The principal feature was to show that no relapse of the malady occurred after the stricture had been cured by means of the electrolysis. As the meaning of the word *cured* may be interpreted by some differently than by others, it will be more explicit to define the meaning, viz.: no contraction of the caliber of the urethra took place, and after the patient had been dismissed as well, to his own satisfaction, the same number of sound, or catheter, that was used the last time in treatment would easily pass after a year, or even many years. These cases were naturally not consecutive cases, but collected from consecutive cases for the purpose, and had to meet the following conditions: (1) That the patients be under treatment regularly, and for a reasonable time; (2) that they were to be discharged cured, or at least so improved that they were content with the result and did not wish any further treatment or improvement; (3) that they were to be cases that were heard of afterwards by reliable information; mostly by reexamination. Some of these patients came repeatedly for such a reexamination. (4) The proof of no relapse was, that the same number of sound was used in the reexamination that passed the last time at the close of the treatment, that is, if the caliber of the urethra was enlarged to a No. 26 French, the same number passed again after 3 to 11 years, respectively.

96. The second hundred cases† was selected in a different way. It consisted of the experience of a later period, the narrative of almost consecutive cases taken from the note-book, relating to all such cases that had remained long enough under treatment to warrant a result and in which the necessary information had been furnished and recorded; on the other side, omitting cases that had not been long enough under

*Journal American Medical Association, April 25, 1885; New England Medical Monthly, August, 1885.

†Journal of American Medical Association, September 24, 1887.

treatment, or only seen without treatment, and in which the record is sufficient. The patients were dismissed or stopped treatment themselves when they felt comfortable and well, had a caliber of the urethra that enabled them to void freely a good large stream, and, if they wanted, could exercise a sexual intercourse. The result of such treatment is noted under the heading "Sequel and Caliber of Urethra When Discharged." The number of the electrode used is stated according to the French scale.

97. The third hundred cases differs somewhat from the first two, as this is the hundred consecutive cases treated by us, and even if treated only temporarily, the result is stated regardless of whether the patient remained under treatment long enough for an expected favorable result or left for some reason before being cured. Excluded from the consecutive order were only consultations, or patients that were seen once and came for an examination or diagnosis.

RECAPITULATION

98. The enlargement of the caliber of the urethra by the electrolytic treatment was as follows:

Strictures that admitted no instrument were enlarged from No. 24 to 28 French, respectively.

Strictures that admitted a No. 4 instrument were enlarged from No. 14 to 28 French, respectively.

Strictures that admitted a No. 6 instrument were enlarged from No. 17 to 28 French, respectively.

Strictures that admitted a No. 7 instrument were enlarged to No. 20.

Strictures that admitted a No. 8 instrument were enlarged from No. 21 to 28 French, respectively.

Strictures that admitted a No. 9 instrument were enlarged from No. 17 to 28 French, respectively.

Strictures that admitted a No. 11 instrument were enlarged from No. 20 to 28 French, respectively.

Strictures that admitted a No. 12 instrument were enlarged to No. 28.

Strictures that admitted a No. 13 instrument were enlarged from No. 26 to 28 French, respectively.

Strictures that admitted a No. 14 instrument were enlarged from No. 26 to 28 French, respectively.

Strictures that admitted a No. 15 instrument were enlarged from 25 to 28, respectively.

Strictures that admitted a No. 17 instrument were enlarged from No. 20 to 28, respectively.

Strictures that admitted a No. 18 instrument were enlarged from No. 25 to 32, respectively.

Strictures that admitted a No. 20 instrument were enlarged from No. 25 to 28, respectively.

Strictures that admitted a No. 21 instrument were enlarged from No. 25 to 32, respectively.

Strictures that admitted a No. 23 instrument were enlarged from No. 27 to 30 French, respectively.

Strictures that admitted a No. 25 instrument were enlarged from No. 30 to 32, respectively.

99. The result of the enlargement of the caliber of the urethra varied according to circumstances; as, necessities, wishes of the patients, time allowed for treatment, nature of the stricture, complications, general condition as to occupations, vices or virtues of the patients. But, results must be considered very good, even by chronic grumblers, if a caliber of an urethra can be enlarged to a No. 28 French, when at the first visit no instrument would pass, and experts have tried in vain before. In some cases, the family physician had tried for weeks; in others, celebrated professors were given chances without being able to pass any instrument, and the disposition of the cases were the advice of perineal section. In some cases, this advice by the family physician was accompanied by a written introduction to a first-class operator, etc. In all such cases, when no medical hand could pass the stricture with an instrument, it was passed successfully by the power of the "electrolysis," which acted as a chemical absorbent, and not as a dilator, as some kind friends have suggested. If, in these cases, dilatation could have been used, why did the experts and surgeons not do it? All these

are facts that can be verified by reliable witnesses, and there can be no doubt that the electrolysis did the work, which could not be done by pressure or dilatation.

The duration of the strictures at the time the patients presented themselves for treatment varied from 3 months to 53 years, and in recapitulating we find two cases that had a standing of 3 months; three cases, 6 months; two cases, 7 months; one case, 9 months; nine cases, 1 year; eleven cases, 2 years; eight cases, 3 years; five cases, 4 years; eleven cases, 5 years; five cases, 6 years; four cases, 7 years; five cases, 8 years; three cases, 9 years; ten cases, 10 years; one case, 11 years; five cases, 12 years; four cases, 15 years; two cases, 16 years; two cases, 17 years; five cases, 20 years; one case, 23 years; one case, 24 years; one case, 32 years; and one case, 53 years.

100. The *percentage* of single or multiple strictures is given below:

Series of Cases	Single	Multiple	Total Number of Strictures
First hundred	42	58	189
Second hundred	21	79	230
Third hundred	34	66	192
Average per hundred in the three		32	67

We may expect nearly one-half of patients presenting themselves having single strictures. The increase of multiple strictures in these statistics may arise from the fact that more bad cases were transferred to us.

101. The *number* of strictures in one individual we find as follows:

Number of Strictures	First Hundred Cases	Second Hundred Cases	Third Hundred Cases	Average Per Cent.
One in	42	21	34	32
Two in	34	43	43	40
Three in	17	26	19	21
Four in	5	7	4	10
Five in	2	1	0	1
Six in	0	2	0	1

102. The *location* of the strictures was found in all parts of the urethra, from the meatus to more than 8 inches from it, as follows:

Location	First Hundred Cases	Second Hundred Cases	Strictures in Third Hundred Cases	Average
At meatus or less than 1 inch from meatus	8	9	1	6
At 1 inch or less than 2 inches from meatus	12	12	5	10
At 2 inches or less than 3 inches from meatus	31	24	25	27
At 3 inches or less than 4 inches from meatus	25	41	31	32
At 4 inches or less than 5 inches from meatus	42	30	35	36
At 5 inches or less than 6 inches from meatus	37	46	51	45
At 6 inches or less than 7 inches from meatus	24	40	30	31
At 7 inches or less than 8 inches from meatus	0	20	14	11
At 8 inches or more from meatus	10	8	1	6

103. Situation.—The greatest number of strictures were from 4 to 6 inches, or in the first part of the urethra; in the membranous part, 15 per cent.; in the prostatic part, 5 per cent. This combined statistic of these three hundred cases confirms the observations made at the report of the first series, that strictures appear in every portion of the urethra, about 15 per cent. in the membranous and about 5 per cent. in the prostatic portion, some of the latter being of traumatic origin. It seems to be a mistake to believe that there are no strictures in the prostatic portion of the urethra, and that the largest number are situated within 3 inches from the meatus.

Séances, intervals, and time-treatment average exactly alike in all series reported. From one to ten operations, in some cases, even more, were necessary, from which fact one may draw the conclusion that the average number of séances was

five to six for each case. The treatment in each case averaged 2 to 3 months. Long intervals between the séances and weak currents are the most important factors in these operations. The intervals should be once a week or more, but in case of necessity may be shortened; each séance should last from 2 to 10 minutes. The electric current is from 3 to 5 milliamperes of a good galvanic battery, having a steady current. Precision and measurement of the electric current are important.

104. Objections—Unjustly Made.—In reality there can be no valid objections to the method of electrolysis in the treatment of urethral strictures, and those that have been raised from time to time come either from men entirely ignorant of the first physical laws of electricity or from such as have had a personal interest or feeling in the matter. To the latter class in the opposition belong some surgeons of high standing, who are wedded to the knife, have not tested the electrolysis, and hence are opposed to any innovation. Most of such objections are unfounded, based on false theories, or are too trivial and too ludicrous to be considered. Some have even the stamp of misstatements purposely made. One friend objects to the treatment because it does not always cure a prostatitis or any other discharge. Of course it does not always. Discharges will only be cured if their existence is caused by stricture; but if there are granulations, or other causes, electrolytic treatment has nothing to do with it. Some are aggrieved to hear that to succeed it is necessary to understand electricity and the handling of the genito-urinary instruments. Now, there is scarcely a profession, business, or even common labor that can be exercised without an apprenticeship, and in any vocation expertness is needed to be successful. The same objection could be raised to any operation, or even to the practice of medicine.

A London surgeon does not like the long intervals between séances, without giving any reason for it. If necessary he may operate at shorter periods. One distinguished operator, who is most persistent in his opposition to this method, argues as follows: "Electrolysis is a heat; heat burns; burns make cicatrices; cicatrices make every stricture worse; ergo,

electrolysis is no good!" Now, that surgeon should know better after having read articles on the subject and heard explanations. It is distinctly advised, always practiced, and insisted on to use weak currents from 2½ to 5 milliamperes, so that the electrolysis acts as a chemical decomposition by absorption, which never burns or destroys tissues. If some surgeons use too strong currents, or the positive, instead of the negative, pole, they make gross mistakes, must necessarily fail, destroy tissues, and ruin their patients. If professors and others have made such mistakes and failures, it is to be lamented, but does not harm the reputation of a good method which is approved by acknowledged successes in a large number of cases all over the world. It is more than ludicrous to read the report of an operator that has the naïveté to measure electricity by a thermometer.

105. Failures.—As the success is dependent on the laws of physics and chemistry, there should be no failures if the treatment is carried on according to such laws. As there have been reports of failure even by excellent medical practitioners, the cause must be in either of the following four reasons: (1) Incompetence of the operator; (2) mismanagement of the case; (3) wrong diagnosis; (4) faulty instruments.

1. *Incompetence of Operator.*—To succeed, the operator must be an accomplished surgeon and electrician, knowing the difference between a galvanic and an induced current, in the first place, and, secondly, having some knowledge of the different results obtained by each current on animal tissue. He must be an accomplished surgeon, so as to be able to lightly introduce instruments into a diseased urethral canal and safely guide them through all parts of an abnormal or pathological passage.

2. *Mismanagement.*—Others, though having enough knowledge of the subject, will fail on account of carelessness. They do not give time to the details, are without any perseverance, and become easily discouraged if their first trials do not give them perfect results. From a letter of a prominent physician it was plainly shown that the doctor, in treating the case, violated nearly every rule that would lead to success.

First, he passed an electrode that gave pain; pain should not

be given under any circumstances. If soreness is already present, it should be removed by appropriate remedies. *Second,* he did wrong to give an anesthetic; where there is no pain an anesthetic is not required. The patient should be able to express his feeling as a partial guide to the operator. *Third,* the current used was entirely too strong. *Fourth,* more than one electrode was passed at a single sitting. The invariable rule is that no two instruments should be passed, even for several days after the operation. *Fifth,* 2 days later an English sound was passed, making the stricture bleed, which showed that damage was being done to the urethra. No. 8 was selected after No. 9 had passed 2 days previously, which is another mistake. The object is to enlarge the caliber of the urethra, during each subsequent sitting. This treatment also brought on two attacks of urethral fever, which will never happen with proper care. *Sixth,* instead of allaying pain and irritation, the doctor made matters worse by using the sound and producing more irritation.

Notwithstanding all this mismanagement the patient and doctor were pleased with the improvement. One year later the operator wrote, however, that the case did not turn out as well as he could have wished. He acknowledged his errors and reported other more successful cases.

3. *Wrong Diagnosis.*—This consists in attempts at the electrolytic treatment when no stricture exists or is present or the impossibility to pass spasmodic action with electrolysis.

4. *Faulty instruments* certainly may become a cause of failure, though an expert operator may partly overcome this cause by the skilful handling of even rude instruments. Nevertheless, a careful man will select the best instruments as an important factor to his success. Many instrument-makers make cheap, faulty articles or useless alterations, in order to compete with honest work.

106. Relapses.—These do not take place when the stricture has been cured and the patient discharged. The reason for such a statement is that in a cure the pathological condition has been absorbed by the decomposition, which is an entire removal of the stricture and its cause. The conditions for declaring

patients cured are: (1) The patients being under treatment regularly, and for a reasonable time. (2) That they were to be discharged as cured, or at least so improved that they were content with the result and did not wish any further treatment or improvement. (3) That they were to be cases that were heard of afterwards by reliable information. Some of these patients came repeatedly for such reexamination. (4) That a reasonable time had been allowed between the discharge, when cured, and the reexamination, which in these cases was from 3 to 11 years, respectively.

The proof of no relapse was that the same number of sound was used in the reexamination that passed the last time at the close of the treatment, that is, if the caliber of the urethra was enlarged to a number 26 French, the same number passed again after 3 to 11 years, respectively; and at the present time, patients can be shown who, after being cured, have been well without a relapse for 26 years.

Now, in conclusion, electrolysis of urethral stricture must and will succeed, in proper hands, in every case that is intelligently and judiciously undertaken. The operation itself needs a clear head, a steady hand, fingers that both see and feel, and patience and good discrimination in the application of the strength of current and length of sitting. In the strictest sense of the word, there can be no failures in dissolving the dense tissue that constitutes a stricture, for electrolysis is based on a fixed chemical action of the constant current on these animal tissues. *Electrolysis cannot fail, but operators may, and do.*

REVIEW OF OTHER METHODS OF TREATMENT

107. The above method of electrolysis for the treatment of urethral stricture has been described in detail, as it has been practiced successfully in many thousand cases by different operators and is therefore recommended. There are other methods that may be used in certain cases, and are mentioned here in order that the student may know of such methods.

108. Fort's Linear Electrolysis.—Fort's so-called *linear electrolysis* consists in the use of an instrument like an

elastic catheter, with a filiform attachment, Fig. 26. Into this catheter, at the lower end, is set a triangular platinum knife. The shaft of the instrument has a caliber of a No. 11 French, and the knife cuts to No. 26 French. A current of from 10 to 20 milliamperes is used for a short time, from 10 to 60 seconds, during which the knife is pushed through the stricture. This instrument has a striking similarity with Doctor Butler's instrument, described in the American Journal of Electrology and Neurology, New York, Vol. I, No. 2, October, 1879, page 95.

Fort's operation is made in one séance, and is in reality a divulsion, and *not* an electrolysis. McNamara's divulsion has done well in some cases, but in others has failed. More could

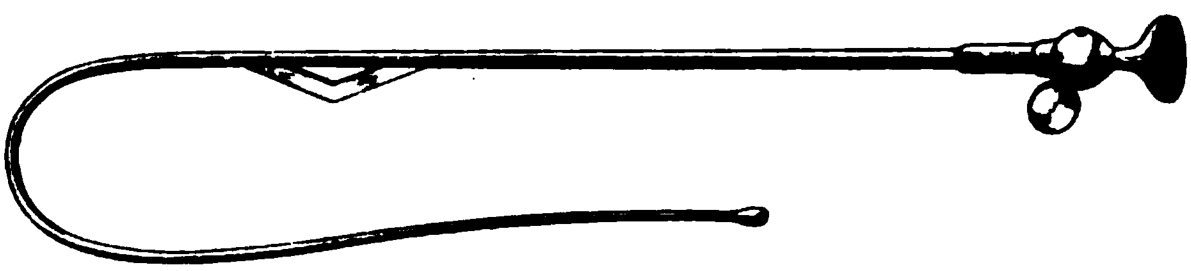

FIG. 26
Urethral Electrolyseur of Doctor Fort

be said about Fort's linear electrolysis, but after careful consideration, the conclusions are: (1) That the current of 10 milliamperes can give very little, if any, chemical decomposition in 30 seconds. (2) That a strong current may cauterize, but is not effective in 30 seconds. (3) That the action is in reality a divulsion, which, under certain conditions, is not free from danger. (4) That the instrument has a similarity with Butler's device. (5) That the instrument is patented. (6) That the procedure is not an electrolysis, rather uncertain, and we cannot recommend it.

109. Gradual Dilatation.—This is an ideal treatment, and may succeed in some contraction of the mucous lining, but in an organic stricture, with new fibroid tissues formed in the surroundings of the urethra, it will fail. The dilatation acts only temporarily like an elastic band, which retracts as soon as the dilator is removed.

110. Cutting Operations (Urethrotomy).—These can only divide the obstruction in one line and in one place,

leaving the other parts of the constriction intact. Even if an incision enlarges the caliber, one of two things will follow: either the divided surfaces come in opposition and then heal by first intention, thereby restoring the stricture just as it was before the cutting operation, or the divided surfaces are kept apart and stretched, in which case the healing must take place by granulations and subsequent formation of cicatrices, leaving the patient uncured and in a condition still requiring the use of a sound. This is admitted even by the principal advocates of cutting operations. Some voices in the profession have protested against urethrotomy, and such have been mentioned.

111. Rational Treatment of Strictures of the Male Urethra.—John Harvey Girdner, M. D., says: "From the standpoint of antisepsis, the operation of internal urethrotomy is a most glaring inconsistency, and a violation of the known laws of nature, as applied to this part of the organism. You cannot cut a stricture internally, without at the same time cutting some of the sound tissue in its neighborhood. Should the patient escape these dangers of infection, the worst is to follow, for after this traumatism, nature adopts her old method of preserving the integrity of the urethra, and deposits more lymph at the seat of the stricture and in the adjoining healthy tissue, which in time organizes, and contracts; and not the old stricture, but a tighter one is formed, and the last state of that urethra is worse than the first."

Dr. J. P. Tuttle* said, at the meeting of the New York County Medical Society, May 25, 1896, that the whole principle of dilatation and internal urethrotomy was wrong. The success of internal urethrotomy depended, not on the thoroughness of the cutting, but on the thoroughness with which the urethra was dilated after the internal urethrotomy. Dr. N. Senn declared cutting-operations in strictures a failure, in his essay at the New York State Medical Association, held October 28, 1891. The objections to internal urethrotomy are: (1) It does not cure; (2) chordee is a frequent sequence; (3) the mortality is about 4 per cent.

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*American Medico-Surgical Bulletin, June 6, 1896, page 794.

DISEASES OF THE URETHRA

GONORRHEA, OR URETHRITIS

112. In the acute stage of this disease, very little can be done, as it causes pain that the patient will not endure. An authority of France, Doctor Doumer, has reported success by the employment of high-frequency currents.

Metallic electrolysis has also been used for the chronic form of urethritis. This is possible, but we cannot recommend it, as it may cause severe contractions of the urethra.

Dr. H. T. Webster, of Oakland, Cal., reports* decided success in the treatment of gonorrhea with the faradic current. He introduced an urethral electrode into the urethra an inch, and then turned on a current of faradism, the electrode being connected with the positive pole, while the negative pole was a sponge held in one hand. The pain was reduced in a few minutes, and 20 minutes of the faradization relieved entirely; a good night followed with comfort. Ten days were needed for a complete cure, during which time daily applications of the faradic current were given. No sequel of gleet followed, the patients making excellent recovery.

GLEET

113. Several authors have reported good results with the faradic current. The late Doctor Steavenson, of London, used the negative pole in the urethra with an urethral electrode connected with the negative pole. The electrode connected with the positive pole was placed on some indifferent part of the body, but by preference over the lumbar plexus, as possibly the effect of the electricity on the nervous supply of the urethra may be beneficial. As a rule the benefit arises from a stimulation of the mucous membrane and the glands. A sound may be used, but it is still better if a part of such electrode is insulated and only 2 or 3 inches used for direct contact with the mucous membrane of the urethra with a current from the

*Massachusetts Medical Journal, Vol. 14, No. 8.

fine-wire coil of the physician's induction-apparatus. The pole for the urethra must be selected according to indications, with a preference for the positive pole. The applications must be given for 10 minutes every third day.

114. Urethritis Chronica Glandularis.—This form of gleet has been described by Oberlaender as a pathological condition or inflammatory process, chiefly in the glands over the mucous lining of the cavernous urethra. The diagnosis of such a state can only be made by an ocular inspection with the urethroscope. Dr. G. T. Mundorf, of New York, has made a study of this disease, and written a paper that was published in the Medical Record, August 20, 1898. The treatment is made by electrolysis through the urethroscope in a similar manner as in strictures. The negative pole is used in the urethra, and the positive moist sponge-electrode applied over the abdomen. A galvanic battery must be chosen just the same as in the treatment of strictures.

It is best for the physician to stand to the right of the patient (the patient being seated in a reclining chair), for reason that the steps necessary to the operation can be followed more conveniently. The endoscopic tube is introduced to the bulbous portion of the urethra and then slowly withdrawn until a diseased glandular opening comes into view. The tube is now held steadily with the left hand, the sound is thrust directly into the opening of the duct, and the electric circuit is closed. In a few seconds, the following phenomenon is observed, showing that the electrolytic action is in play: A ring of grayish-white foam is seen to form around the electrode, somewhat obscuring the field of operation. At this stage it is best to disconnect the current, remove the electric needle, and then, by means of a cotton swab, dry the mucous membrane. The needle is not to be withdrawn from the tissues until the current has been disconnected at the battery, thereby avoiding a disagreeable shock. The operation can then be continued.

The strength of the galvanic current is about 4 milliamperes, and the current is applied to each affected gland for 30 seconds, or until the electrolytic action has produced the desired effect.

Not more than three glands should be electrolyzed during one session. Between the séances there should be an interval of 4 or 5 days. Mild urethral injections can be given 1 day after the operation. Endoscopic examinations should be made for the ocular inspection and operation.

GRANULAR URETHRITIS

115. This disease has a striking similarity with granulation of the eyelids. Electrolysis could be employed for the treatment, but the usual successful medication is a local application of the diseased foci through the urethroscope,* which we have practiced for many years. The following illustrations may explain the changes before and after the local application, which have been made from nature by an artist who had studied and graduated in a medical college. He made the sketches from nature, seeing them through the endoscope.

EXPLANATION OF FIGURES

In Fig. 27, (*a*) and (*b*) represent the same spot before and after the solution of nitrate of silver has been applied.

(*a*) represents the mucous lining of urethra altered by chronic disease, thickened, indurated, and of a dark, brownish color. Granulations are represented by the elevations and the darker color.

(*b*) is the same as (*a*). The solution has changed the color to a whitish gray, but the form is retained.

(*c*) and (*d*) represent the same place before and after the application of the solution.

In (*c*), the longitudinal fibers radiate from a center to the periphery, between which the granulations are distinctly seen, like strawberry eminences. The whole surface is intensely

*R. Newman. "The Endoscope in Granular Urethritis in the Male." American Practitioner, August, 1871, Louisville.
Fenwick. "Electric Illumination." Churchill, London, has many references to the bibliography of endoscopy.

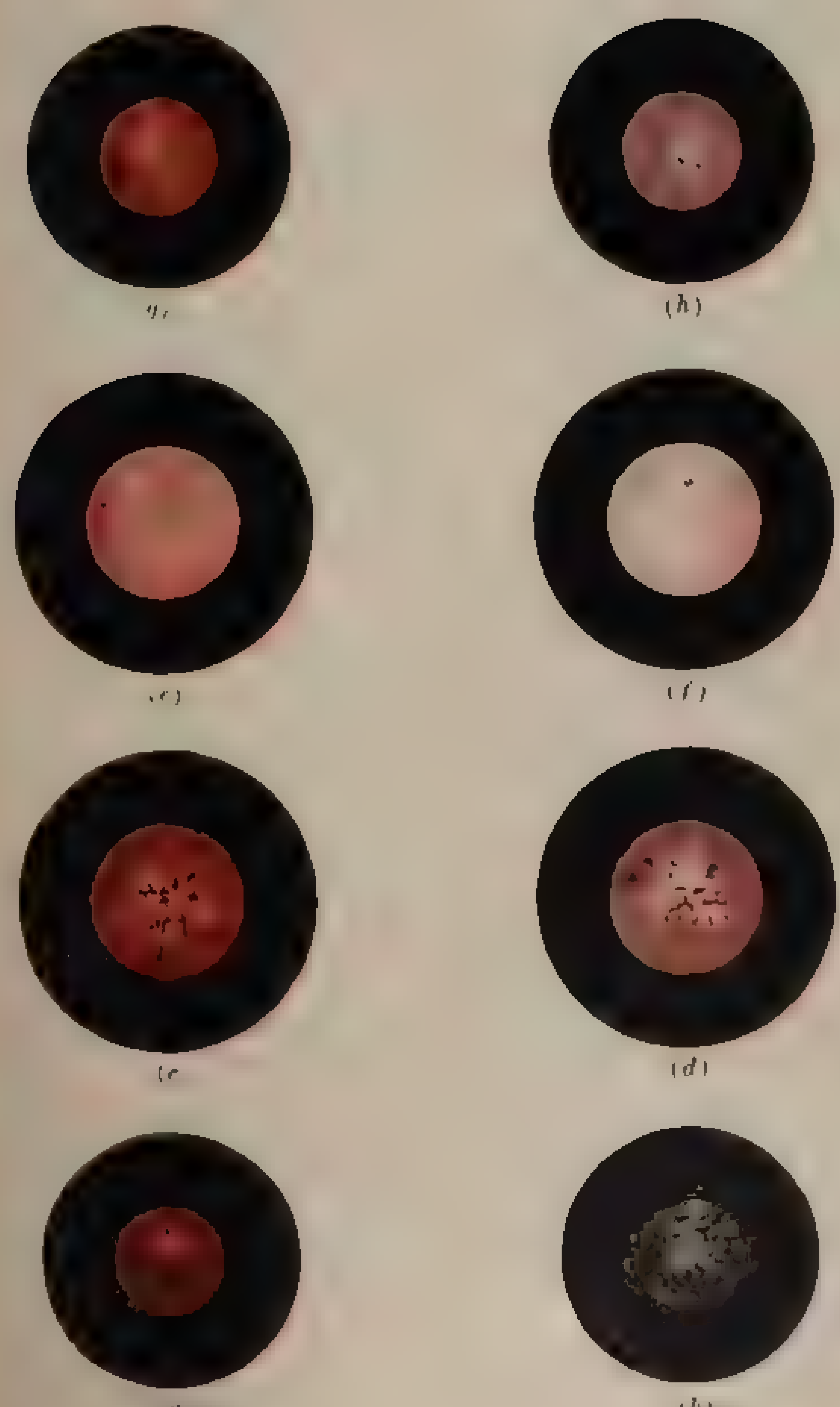

Fig. 27

Granular Urethritis in the Male

inflamed and injected with blood. The structure is not altered as at (*a*).

(*d*) is the same place after the application of the solution with a glass-brush. The whole surface has now instantaneously changed to a pale, more normal, color.

(*e*) represents a part of the urethra restored to health by the treatment. Two months previous it looked exactly like (*c*).

(*f*) represents the last diseased spot in the urethra, 2 inches from meatus, to which the solution has been applied slightly. The color is now paler, as in health.

(*g*) represents a large inflamed surface in the urethra, ½ inch from meatus, deprived of its epithelium and covered with bloody exudation. In the middle is a depression—a loss of substance that suppurates.

(*h*) is the same place after the solution of nitrate of silver has been applied.

STRICTURE OF THE ESOPHAGUS

116. The treatment of *esophageal strictures* is almost the same as those of the urethra, and is mentioned here on account of that similarity. Successes have been achieved by electrolysis in cases in which other means had failed. Cutting-operations from below followed by gradual dilatation have been reported as successful, particularly by M. H. Richardson, of Boston, professor of surgery at Harvard Medical College. Gradual dilatation by bougies cures only in mild cases, but in constriction from pathological alterations must necessarily fail in the majority of cases. Professor H'Jorth, of Christiania, reported, at the International Medical Congress, in Copenhagen, a severe case in which the stricture had been caused by the patient swallowing an alkali. The contraction that followed was of such a nature that no sound would pass below the cricoid cartilage, and swallowing was nearly impossible. Gastrotomy was resorted to, and electrolysis applied at the part. The current was commenced with 5 milliamperes and gradually increased to 12. After 1 hour, the electrode suddenly passed through the stricture. After an interval of 12 days, a second

application of electrolysis was made, after which the patient could eat and swallow both solids and fluids, and a Charrière bougie, No. 19, passed through the former stricture both ways, from below and above. Two weeks later the gastric fistula was closed by operation.

As a rule the prognosis in esophageal stricture is grave. The elaborate statistics by M. Petit, of Paris, of 155 operations show only 2 per cent. of cures and 75 per cent. of deaths. Therefore, electrolysis in esophageal strictures must necessarily play an important part in the treatment in the future. Other cures by electrolysis have been reported by various operators, as Prince, Butler, Dickman; E. T. Painter, Pittsburg, Pa.; D. S. Campbell, Detroit, Mich.; T. F. Frank.

117. Divisions.—Some authors divide esophageal strictures into different divisions, which we consider unnecessary, and which is confusing to the student. Among these divisions is the spasmodic stricture, which, for reasons already stated, must be excluded, because an occasional spasm is no stricture, and therefore no electrolysis is indicated. To another class, belong strictures of a malignant nature, which are almost always hopeless. Electricity may give a temporary relief, but a cure cannot be expected. The remaining subdivisions are fibrous and cicatricial, which in reality means the same thing as a stricture caused by an inflammatory process, whether acute or chronic. By *organic stricture* is meant the class in which the electrolysis is indicated, and in most cases will be followed by a cure.

118. Etiology.—The etiology of strictures are usually of a traumatic nature, caused mostly by the swallowing of caustics, like lye, oxalic acid, corrosive sublimate, etc., all of which cause a serious inflammation. If an obstruction is caused by the swallowing of a foreign body, like false teeth, which cannot be dislodged, nobody would think of applying electrolysis, and operative measures are indicated.

119. Diagnosis. — Diagnosis is made easily by the history of the case and by an examination with a bougie,

which will be arrested at the seat of the stricture. Modern instruments, with electric light, will illuminate the stomach, and such an endoscopic examination may assist the diagnosis and treatment in some cases.

120. Instruments.—A galvanic battery described as suitable for the treatment of urethral strictures must be used, and firm, flexible electrodes of different sizes complete the armamentarium. Each size must be made in one solid continuity It is very dangerous to have bulbs of different sizes that screw on one stem. No bulb that screws is safe, as it is liable to unscrew in time and drop, which new obstruction may cause the patient's death or at least necessitate a dangerous operation. For each size, a separate electrode must be made in one firm continuity. The bulb is egg-shaped, and soldered to one end of the wire; the other end of the wire is fastened to the metal that connects the cord to the negative pole of the

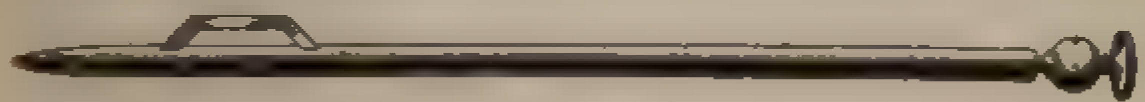

FIG. 28

Esophageal Electrode of Doctor Fort

battery. Around this wire another is wound spirally. The whole instrument is incased in a rubber tube, only leaving free the ends where the bulb and the connection for the battery are. We have devised a new improvement in which the central wire is omitted. Only a spiral wire is used, which makes the electrode more flexible and yielding. The length of the electrode should be 21 inches.

121. Modus Operandi.—The diagnosis has been made, the stricture found and measured, and the size of electrode necessary selected. If practicable, an ocular inspection with electric light might assist the diagnosis. Antiseptic measures can be used, particularly the atomizing of the mouth with a solution of boric acid or borolyptol. The patient is seated in a comfortable chair, so that he can bend his head backwards. The electrode selected for the operation and connected with the negative pole of the galvanic battery is introduced through the

mouth into the esophagus, if possible to the seat of the stricture. Then the patient takes the other electrode from the positive pole into the palm of his hand. This electrode may be carbon covered with felt or cotton and well moistened. Then the current is turned on from zero, cell by cell, to about 10 milliamperes. If the patient is not inconvenienced and the stricture is very dense, the current may be increased to 15 milliamperes. The operator holds the bulb against the stricture with ease and guides the electrode through the stricture and then into the stomach, in order to have the whole track well enlarged. Then the electrode is slowly withdrawn until the stricture has been passed, and the current is diminished again, cell by cell, to zero, when the electrode is entirely removed. During the operation the patient must control spasm and cough as best he can, and wipe off the saliva discharging from the mouth.

The séances can be repeated according to the tolerance of the patient, and the urgency of the symptoms. The duration is also dependent on circumstances, and may last from 3 to 20 minutes. Most patients cannot endure a longer period than 5 minutes. At each time, if possible, a larger sized electrode should be used. The operator must use good judgment and care, and be directed by the circumstances of the case and the tolerance of the patient.

We have had good results. Patients with stricture that could scarcely swallow milk or water were much improved and cured in a short time. In one case of very bad stricture, the patient after one application of electrolysis could drink well and did eat porridge of oatmeal; after the second application he could eat meat. The stricture was 13 inches from the teeth. The electrode passed and advanced to 15 inches. The electrodes must be made more flexible than the usual esophageal bougies made for gradual dilatation.

122. Electrocautery has been used in these strictures, and may succeed in some cases. However, it needs great care and experience, and should be made with the assistance of electric light for ocular observation. Strictures in other parts

of the body have been treated successfully by electrolysis. They may be enumerated as follows: Strictures of the female urethra and stenosis of os uteri; obstructions in the Eustachian tube, which often are the cause of deafness; strictures of the lacrimal duct, the nasal duct, and also anterior hypertrophies of the inferior turbinated bones. The treatment is similar to that described under urethral strictures; but details cannot be given here, as the diseases mentioned have already been treated.

STRICTURE OF THE RECTUM

123. This disease is very important, as it causes lots of anxiety, pain, and often increases so much that it is the real primary cause of death. In no instance has electrolysis achieved more successes than in this malady. Excluding such cases as have originated from malignant growths and syphilis, a cure can be promised and expected from electrolysis. Other means have too often failed, and a necessary colotomy is generally a torture and the beginning of the end.

Dr. George H. Rohé, of Baltimore, says:* "The treatment of stricture of the rectum by gradual dilatation or linear proctotomy is notoriously unsatisfactory. All surgeons admit the inefficiency of the first and the danger of the second. In electrolysis, we have a safe and apparently efficient method of treatment."

Dr. W. E. Steavenson writes:† "Strictures of the rectum can, like all other strictures, be treated by electricity. In the majority of cases there is no recontraction or return of the stricture, but, if due to cancer, a fresh growth of diseased tissue is very likely to take place, necessitating a recourse to the treatment. Successive applications of electricity are far better than the dernier resort of colotomy, and may keep the intestines patent as long as the disease allows the patient to live."

Endorsed by other equally eminent authorities, we emphatically join in recommending the adoption of electrolysis as *the*

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*Atlanta Medical and Surgical Journal, July, 1888, page 297.

†"The Uses of Electrolysis in Surgery," by W. E. Steavenson, M. D.

treatment for rectal strictures. This opinion is further strengthened by experience and successes, some of which have been published.* We have successfully treated strictures of the rectum by electrolysis since March, 1871,† and, as the literature on this subject records no cases prior to 1871, we believe we are the originators of this method. The plan of treatment followed in those cases is almost identical with the method of treating urethral strictures by electrolysis.

124. Instruments.—The armamentarium consists of a good galvanic battery with conducting-cords, handles with sponge-electrodes (a few binding-screws), a set of rectal electrodes of different sizes and shapes, and a milliammeter to

FIG. 29

Newman's Rectal Electrode

measure the electric current. The electrodes have at one end a metal bulb—copper or brass, silver- or nickel-plated. The form is flat or egg-shaped. They are made in sets of different sizes; the length is from ½ to 1½ inches, and the circumference from 1½ to 3 inches. The stem of the electrode, except at the

*Journal American Medical Association, May 17, 1890.

†Specimen presented to New York Pathological Society, April 10, 1872. New York Medical Record, Vol. VII, 1872, page 208.

extremities, is insulated with hard or soft rubber; some are flexible, others stiff. If larger sizes are needed, a metallic bulb is used, similar in shape and size to vaginal electrodes, which are from 3 to 5 inches in circumference.

The best electrode (Fig. 29) for examination and treatment has recently been devised, which consists of a bulb on a spiral stem, insulated with a rubber covering. The instrument will accommodate itself to the flexures and easily enter the colon, thereby increasing the field of observation. Undue force is prevented; neither can the tube double up or turn on itself. If made long enough, it will enter into the transverse colon, where the bulb can be distinctly felt, and in some instances it can even be seen bulging out.

125. Modus Operandi.—The patient may be placed in the Sim's position, on the left side; but in the majority of cases the lithotomy position, on the back, is preferable, because in the examination and operation the anatomical relations of

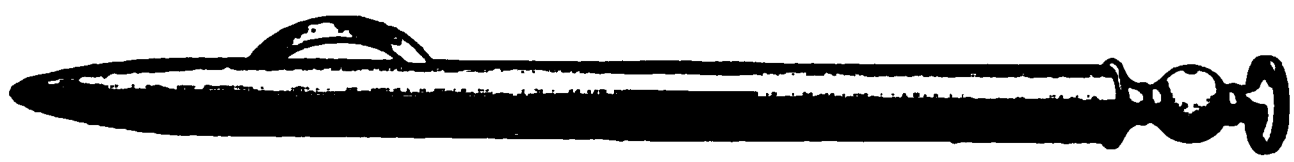

FIG. 30
Doctor Fort's Rectal Electrolyseur

rectum and colon with the sigmoid flexure can be better appreciated. The galvanic battery is brought into action with the switch at zero. The sponge-electrode, wet with warm water and connected with the positive pole of the battery, is placed firmly in the palm of the patient's hand, but in some cases may be pressed on the abdomen or thigh. The negative metal electrode is lubricated with glycerin and inserted to the seat of the stricture, and then the electric current is slowly increased from zero until the desired strength is reached, which is ascertained mainly by the sensation of the patient. The strength of the current allowable varies from 5 to 15 or even 20 milliamperes, according to the seat of stricture, the nature of the neoplasm, the size of the electrode, and the susceptibility of the patient, the rule always being not to use a strong current if a

weak one will accomplish the object. The séance may last from 1 to 15 minutes. No force should be used; the electrode should be kept steadily against the stricture, and only guided; the electrolysis does the work of enlarging the caliber as the instrument passes the obstruction. At the end of the séance, the current is slowly reduced to zero, and not until then is the electrode to be removed.

It will be perceived that the occasionally stronger current in this operation is the only difference from the treatment of urethral strictures. Séances may be repeated in 1 or 2 weeks. According to circumstances and complications of the disease, some modifications of the treatment may be called for, one of which is the use of needles in the mass of the stricture instead of the metal bulb at the negative pole. The smaller electrodes are very flexible and long, the object being that undue force is impossible while being used. Some operators use stronger currents, particularly if anesthetics are used. Doctor Earle has used 50 to 100 milliamperes. We have witnessed an operation by Dr. W. F. Hutchinson where 39 milliamperes were well tolerated. If neoplasms are present, or carcinoma is suspected, stronger currents are indicated; they may be practiced under an anesthetic with needles in the same manner as in the treatment of tumors. Such are exceptions, and in carcinoma, an improvement and even a cure may be effected if the neoplasm is local and confined to a small area where the needles can destroy it.

126. Recapitulation.—In recapitulating the facts in these cases, we find some interesting items. It seems that females are more inclined to have rectal strictures than males. In 367 cases collected by Charles B. Ball, 276 were females and 91 males. In twelve cases observed by us only two were men. Their ages were mostly between 30 and 40 years, the youngest being 24 and the oldest 62. The two males were comparatively young men, being 23 and 26 years old, respectively. Eight cases were single strictures, and four were multiple strictures. The duration of the malady was from 6 months to 20 years. The causes varied, but hemorrhoids and constipation

TABULAR STATEMENT OF REPORTED CASES OF RECTAL STRICTURE

Cases	Sex	Age	Strictures No.	Strictures Location	Strictures Duration	Cause and Complication	Result of Previous Treatment	Result of Electrolysis	Remarks and Sequels
1. M. V.	F.	24	1	$2\frac{1}{2}$ in.	6 mo.	Venereal; five fistulæ.	Dilatation; no success.	Cure.	Post-mortem specimen showed no relapse.
2. Mrs. D.	F.	62	1	4 in.	2 yr.	Constipation; atony.	Medical; no success.	Cure.	No relapse in 10 years.
3. Mrs. P.	F.	30	1	$1\frac{1}{2}$ in.	5 yr.	Syphilis; pelvic cellulitis.	Dilatation; proctotomy, etc.; relapse.	Cure.	Remained well, as long as heard from, for 10 years.
4. M. B.	F.	38	1	$2\frac{1}{2}$ in.	2 yr.	Hemorrhoids; constipation.	Operation; relapse	Cure.	Not heard from.
5. Mrs. M. A. C.	F.	36	4	2, 3, $5\frac{1}{2}$, and 10 in.	5 yr.	Syphilis; malaria, tuberculosis.	Dilatation; relapse	Improved.	Not heard from.
6. L. S.	F.	35	3	$1\frac{3}{4}$, 3, and 5 in.	5 yr.	Constipation.	Proctotomy repeated; relapse.	Improved.	Proctotomy; afterward used rectal bougies; relapse; died Oct., 1888.
7. R. B. A.	F.	43	2	5 and 10 in.	3 yr.	Membranous enteritis.		Cure.	Heard from; no relapse for 4 years.
8. G. E. W.	M.	23	1	$3\frac{1}{2}$ in.	1 yr.	Dysentery; suspected malignancy.	Failure.	Cure.	Well after 15 years; reexamined 1901.
9. J. M. R.	F.	46	1	$1\frac{1}{2}$ in.	10 yr.	Hemorrhoids, fissure.	Proctotomy; operation; relapse.	Cure.	Well; no relapse in 5 years.
10. E. M. B.	F.	44	2	3 and 5 in.	20 yr.	Hemorrhoids; constipation.	Operation; relapse.	Cure.	Well; no relapse in 1 year.
11. H. K.	M.	26	1	4 in.	1 yr.	Dysentery; proctitis, prolapsus, constipation.	Medical.	Cure.	Well; no relapse in 4 years.
12. B. L.	F	30	1	$2\frac{1}{2}$ in.	3 yr.	Tumor of uncertain nature.		Cure.	Well; no relapse in 4 years.
13. S. T.[1]	F	39	1	2 in.	4 yr.	Polypoid growths.	Dilatation failed.	Cure.	Well after 2 years.
14. H. W.[2]	F.	30	1	1 in.	7 yr.	Specific lesions; neoplasm.	Dilatation; proctotomy; failure.	Much improved	Well after 1 year.

[1] Case reported by Dr. S. Benton, Loudon. [2] Case reported by Dr. S. T. Earle, Jr., Baltimore.

were important factors; other causes were syphilis, enteritis, and dysentery. It is certain that a rectal stricture may follow any inflammation of the rectum. One case was complicated by five fistulæ, commencing in the rectum and ending externally in different parts of the vulvar and gluteal regions. As soon as the stricture was cured, the fistulæ healed without any treatment; two had medical and the balance surgical treatment, six of which had been operated on with the knife. In not a single case had the previous treatment been successful; some were entire failures, and all that can be claimed in some exceptional instances was a temporary relief followed by relapses. Even the most sanguine operator will admit that proctotomy must be followed by the use of a rectal bougie at regular intervals. If we now compare all other methods with the treatment by electrolysis, we find that the latter has at least improved every case, and in the majority of cases has effected a cure.

Cases 5 and 6 were certainly improved, but in the end may not prove satisfactory; one patient had too many complications, and while we have not heard from her, we know she could not have been permanently benefited; the second case (No. 6) was an aggravated one, the patient being too poor to attend to herself, or even to come regularly for treatment. This case was then operated on, and she had to use a rectal bougie regularly, by which means the stricture was kept from closing up again; but after 4 years she had a relapse, with complications, and finally died. Case 8 is a perfect cure, and the patient remained well for 15 years, which fact has been graciously acknowledged by several surgical authorities; while a papillomatous growth, by some pronounced carcinoma, complicated the case to such a degree that a cure could scarcely be expected by any treatment. While two cases were improved, ten cases were cured by the electrolytic treatment, and, as far as known, no relapse has taken place, which were from 1 to 10 years, respectively, except one case, in which nothing has been heard from. The best results were achieved from the same method as used in the treatment of urethral strictures by electrolysis, that means by metal bulbs as negative, and weak currents in intervals But

it is in the nature of the parts treated that the current can be applied stronger and oftener than in the urethra.

127. More recently we have operated on very severe cases with good results. Even in hopeless cases of carcinoma, the conditions were ameliorated and life prolonged. A former house physician of the Long Island College Hospital, later a well-known practitioner in New Hampshire, had a carcinomatous stricture of the rectum, and was so weak and emaciated that he could not leave his bed and had to have constant attendance. After treatment, he was so much improved that he went home, and in a letter stated that he was feeling well, had resumed practice, and on that day had walked 4 miles. A lady who had suffered ten cutting operations for carcinoma came from Italy to New York for treatment. Surgeons made the prognosis that she could not live 3 months. She was so much benefited by electrolysis, that she left again and traveled in Europe for 3 years. Of course, both these patients had relapses, and finally died. We by no means wish to give the impression that we cure carcinoma; these cases are only cited to show that electrolysis does good and even in carcinoma will benefit and prolong life. Constitutional diseases, as syphilis, must be treated by medicines and electrolysis may assist, as the case of Doctor Earle proves.

RECTAL DISEASES

128. Electrocautery and electrolysis have been recommended in various diseases of the rectum by different authors. Doctor Byrne, of Brooklyn, an expert and the inventor of an electrocautery battery, has practiced and recommends electrocautery and electrolysis as follows.

HEMORRHOIDAL TUMORS

129. *Hemorrhoidal tumors*, when isolated, may be clamped and removed with the cautery-knife, the incised stump or edges being subjected to extra cauterization before removing the clamp; and the latter should be allowed to

remain a few minutes after completing the excision, and its grasp released slowly and carefully, so as to avoid hemorrhage. When the tumors are large and occupy the whole or a greater part of the circumference of the anus, the manner of proceeding should be quite different. A wooden plug or clothes-pin, for example, or still better one of glass, ½ to ¾ inch in diameter, with one or more circular depressions, is to be introduced into the rectum as a central point of resistance, and given in charge of an assistant. The loop, now made to embrace the entire mass, is to be very moderately tightened at first, and by an amount of heat, barely sufficient to bring this comparatively short length of wire to a cherry red, the operation is to be very slowly proceeded with until the glass or wooden core, as the case may be, has been reached. In the hands of Doctor Byrne, such an operation has usually occupied from 12 to 15 minutes.

RECTAL FISTULÆ

130. *Rectal fistulæ*, when blind or incomplete, may be treated first by passing a director through the canal to its bottom and incising with a cautery-knife; or second, in case the terminus of the channel should be near the surface, the director may be pushed through, a platinum wire passed, and grasped at either end by the forceps electrode. By a seesaw movement, the fistula can be laid open. The lining membrane of the fistulous tract should then be cauterized in its entire length and the wound packed. The slough will become loosened in 3 or 4 days, when the part should be irrigated and otherwise treated in the usual manner; but there will be no necessity for further packing, as in a case operated on in the ordinary way.

HEMORRHOIDS

131. *Hemorrhoids* have also been treated in different ways, either by the electrocautery or by electrolysis with a metallic working electrode, or with one or two needles. The pole must be selected according to indications. Different methods are used for the operation, and either may be correct, according to

the appearance and location of the hemorrhoids. If an absorption is desired, the negative pole is used; if the tumor is vascular and the intention is to seal up the vessels, the positive pole must be selected. Needles may be used, the selection of the pole being made according to the effect wanted. Sometimes two needles may be inserted into the pile, each being connected with one pole of the galvanic battery. It is best to treat each hemorrhoidal tumor separately. The current may be 10 to 20 milliamperes strong for 10 to 15 minutes. In some instances it is best to remove the tumor with the electrocautery-écraseur. This operation must be done slowly, in order to avoid hemorrhage and close the vessels by the effect of the heated wire. Acute cases that are very painful should not be operated on.

The operation should be preceded by an evacuation of the bowels, and before the operation a cleansing irrigation and possible antiseptic measures should be taken. An anesthetic is not necessary, but the injection of a solution of cocain into each pile to be operated on is desirable. Ocular inspection can be made by the insertion of a speculum. The current should remain closed until the parts change color to a whitish gray, which may be expected within 4 minutes. The electrolytic action results in an absorption. After the séance it will be well to give an opiate as an anodyne and partly to prevent a passage of the bowels for a few days, in order to give a better chance for the healing of the parts. Surgical operations have been successful, and the injection of carbolic acid in a diluted solution has often effected a cure.

CONSTIPATION

132. The daily natural evacuation of the bowels is often interfered with by dietetic errors, but mostly becomes chronic by habitual neglect; and the valves of the intestines will be quasi-paralyzed, non-acting, and the mucous lining loses its tonicity. Cathartics may relieve temporarily, but will not cure the constipation, nor restore the tonicity of the parts. In these chronic cases, electricity will do wonders; and applied

persistently, must cure most cases. Sparks from the static machine, applied for the tonic effect on the liver, pancreas, and intestines, will stimulate these organs to action, but the best treatment is galvanism with small pad-electrodes. Two ways of application are advised. Place the positive pole either over the epigastrium or over the region of the liver. The other electrode, as the negative pole, is slowly moved by a rocking advance in the direction of the peristaltic motion, which is beginning in the right inguinal region, going upwards on the ascending colon, then from right to left over the transverse colon, and downwards on the left side over the descending colon. This must be done slowly, and several rounds made in the same way. From the end of that circle in the left inguinal region the pad must be pushed to the right side without raising it from the cuticle, in order not to cause a shock by interrupting the current. The duration of the séance is about 12 minutes, the current being arranged to the tolerance of the patient, which is about 20 to 25 milliamperes. Three applications should be made every week.

If a stronger effect is desired, a pole in the shape of a round rectal electrode—a small vaginal electrode will do—can be inserted into the rectum. Generally, the positive pole is indicated, but there may be symptoms present that make the negative pole desirable. A careful physician may combine with the electric treatment, medicines and a systematic use of enemas.

PROLAPSUS ANI

133. *Prolapsus ani* is best treated by the employment of the high-tension current from the faradic apparatus. The positive pole is at the prolapsed part; the negative over the abdomen, or may be held in the palm of the hand. The current is given with rapid interruptions, as an induced current with the whole coil, the arms being on the first and seventh buttons. Poles may be changed at times. The current is employed at zero and gradually increased to a strength suitable to the tolerance of the patient. Repetitions are given three times a week.

FISSURES OF THE ANUS

134. French electrotherapeutists, particularly Doumer, have treated this ailment successfully by the high-frequency current. One electrode is inserted through the anus, and the current given for about 7 minutes Repetitions are made until a cure is effected. The usual surgical treatment consists in laying the parts at rest by forcible stretching of the sphincter, which has to be done only once, and in many instances is preferable.

DISEASES OF THE TESTICLE

HYDROCELE

135. The object for a cure is the evacuation or absorption of the fluid and exciting an inflammation within the sac for the adhesion of the walls of the cavity. Cures by single or repeated applications of electrolysis have been reported by Althaus, Rudolfi, Erhardt, and Bartholow. The principal method recommended consists in evacuating the fluid, then introducing two needles into the tunica vaginalis, where the electrolytic action is carried on. The needles must not touch each other, nor the testicles or the cord. Variations of this method may be made. Sometimes only one needle from the negative pole is used, the positive pole being held on the abdomen Failures take place just as well as with other means.

ORCHITIS AND EPIDIDYMITIS

136. The electric treatment given in these diseases is the galvanic current, either to the scrotum or, as Lewandowski recommends, directly over the cord. The parts are very painful, and great care is needed in handling and supporting them. The pads should be placed on either side of the affected parts, with the galvanic battery at zero. The current should be very gradually increased to 5 milliamperes, and just as gradually decreased to zero; the poles should then be reversed, and the current again increased and decreased. The poles may be

reversed in this way several times. Daily applications are necessary. The pain may also be allayed by local applications of the wave-current from the static machine. The wave-current has been recently introduced, and is given by a piece of block tin from the positive pole of the static machine applied close to the cutaneous surface of the part affected by pain.

INFLAMMATION OF SEMINAL VESICLES

137. Each *seminal vesicle* may be called a part or a reservoir of the vas deferens. Its diseases are mostly acute and a tubercular disease, which often is a sequel of a chronic inflammation. External and internal remedies are employed. The electric treatment of the inflammation consists in employing the galvanic current in the following manner: The positive pole, in the shape of a pad-electrode, is placed on the lumbar region, and the negative pole is applied through the rectum to the seminal vesicle. This negative pole may be made of metal, like brass, German silver, or copper, insulated on one side, so that the electrolytic effect is on the vesicle. A small vaginal electrode may also be used for the negative pole. Only a weak current should be given—about 4 milliamperes—for a period not longer than 5 minutes. The application must not be repeated too soon—the interval should be 5 days. Dr. W. B. Snow has recently devised for this purpose an electrode of metal. This electrode has a hollow groove, so that it can be adapted to the vesicle and also to the convex surface of the prostrate gland. He used it for applying the wave-current and reports marked success in cases of prostatitis.

SPERMATORRHEA

138. Definition.—According to the derivation of the word, *spermatorrhea* means the unnatural ejaculation of semen that contains spermatozoa. This disease is very rare, and usually patients who come for treatment for spermatorrhea have only pollutions, either nocturnal or diurnal, in which an electric treatment may be advisable. Occasional emissions in long

intervals need scarcely any treatment, as the cause may be an overflow, an extra sexual excitement, or a sexual abstinence from the regular habit. However, if the emissions are frequent, so that the patient's health gets impaired, it will be a neurological lesion and treatment is imperative.

139. Etiology, Etc.—This disease is mostly the consequence of masturbation, sexual excesses, mental strain, or overwork, or the sequel of inflammations of organs like the prostate, seminal vesicles, urethra, or cord. The diagnosis is made from the history of the case, the abnormal condition of the patient, and from the examination. The prognosis differs according to the case and circumstances, but is generally favorable. The treatment consists of general dietetic and hygienic measures, tonics, anodynes, rest, and the cessation of all bad habits.

140. The electric applications are nearly the same as those advised for the inflammation of the seminal vesicle. According to theory, the sedative action of the positive pole should be expected to be employed, but the practical experience is that a mild electrolytic action of the negative pole has had the best results. The positive pad-electrode is applied over the spine or the lumbar plexus; the negative pole is directed through the urethra with either a Newman's egg-shaped electrode or with a metal electrode per rectum to the seat of the disease. A current of 3 to 5 milliamperes from a galvanic battery is used for a short time—3 to 5 minutes—once or twice a week. To ameliorate the irritable condition of the affected parts, a high-tension current can be employed from the long fine-wire coil of the faradic apparatus. Local galvanic applications with pad-electrodes may be given over the spine with a descending current, if the spine needs a stimulation, as general tonic breezes or sparks of the static machine will improve the general state of the patient materially.

If the disease is real spermatorrhea, that means an often-repeated emission of seminal fluid with spermatozoa, it is generally due to a prolonged gonorrheal discharge, which has extended posteriorly to the vesicle. The openings of the ducts

are enlarged and weakened, which causes the emissions. Under such circumstances, the object is to give power to the ducts and contract their openings, which is effected by the contractile power of the high-tension current from the faradic apparatus. Another method would be to use Newman's electrocautery-sound. The distance to the ducts has to be measured with the introduction of a flexible cathode and marked on the catheter as soon as the urine begins to flow. This distance, in most cases, 7½ inches, is marked on the electrocautery-sound, which instrument is then introduced into the urethra. The instrument has been previously connected with a secondary battery, and when the cautery-wire has reached the affected part, two or three sparks are given in rapid succession by pressing down the handle. These sparks must not cauterize, and the effect must be only stimulating and astringent, in the same manner as Lellemand intended his applications with the nitrate-of-silver stick.

ASPERMATISM

141. *Aspermatism* is rare, a kind of sterility of the male, with a sexual appetite and power, but without an ejaculation. There may be nocturnal emissions and lascivious dreams. It seems this disease is not sufficiently understood, but appears to be a nervous affection. The indication is to apply the galvanic current over the spinal cord from the ligamentum nuchæ to the perineum as a descending current over the parts mentioned, or in sections thereof. Treatment may be given every other day and the current increased to the tolerance of the patient, stimulation of the cranial nerves being avoided and the strength of the current diminished as soon as a coppery taste is manifested.

URETERS

142. *Ureters* convey the urine from the kidneys to the bladder, and may be affected by continuation of the diseases of these organs. If they are injured by traumatism, the repair must be attended by the surgeon. Obstructions by calculi occur, which need medical or surgical aid, and electricity cannot

do any good In the diagnosis of this condition, catheterization of the ureters is of utmost importance The electric light illuminates the field under observation. There may be many obstacles to the success of an ureter catheterization. It needs an expert operator and a good ureter cystoscope, which is being gradually improved and perfected.

DISEASES OF THE BLADDER

INCONTINENCE OF URINE

143. Electrotherapeutic applications of various kinds have been advised, which sometimes cure and in other cases utterly fail. Considering the different causes of incontinence that often is only a symptom of the malady of other organs, this uncertainty of effect is explained; and this chapter is introduced for the purpose of a *caveat* to the electrotherapeutist If a patient cannot control micturition, by which the urine dribbles away as an overflow, it may be caused by diseases of other organs, as the rectum, prostate, urethra, or bladder, or a paresis local or originated in the spine, thereby acting as a reflex, or a nervous disease from depression or excitement.

According to the cause, the remedy must be selected, and that explains the advice of text-books and report of successes, and the different methods advised. If the cause is a general nervous depression or neurasthenia, perhaps the static application will do best; it should be given as a static breeze to the spine and over the lumbar region, and then, if the patient can tolerate it, sparks can be withdrawn from the patient on the platform Benedikt, of Vienna, advises sparks to the hypogastric region and along the spine. Morton and others use the static machine and a pistol-shaped electrode direct to the bladder and perineum. In some cases, particularly in spinal diseases, galvanization of the spine as a descending current will do well. In simple nervous and paretic diseases, local faradization is indicated. If the bladder itself is affected or the contractile power of the walls is weakened, an insulated sound (except 3 inches at the conical end) is introduced into the bladder as the

negative pole, while a pad-electrode is placed over the region of the bladder. The current must be mild—5 to 6 milliamperes for about 5 minutes. Any electric application for this malady should be given as weak currents and for short terms, from 4 to 5 minutes at a séance. Another excellent method is to use hydrogalvanism, as formerly explained, to electrify the water injected into the bladder. It may be difficult to select the correct method, but the physician has to exercise good judgment, firstly to make a correct diagnosis, and secondly to select the treatment indicated, and pursue it systematically with reason.

ENURESIS IN CHILDREN

144. *Enuresis in children* is in reality a nocturnal incontinence, which has been described very well by Dr. Mary Putnam Jacobi. According to causation, galvanism or faradism is advised. Steavenson has had successes with galvanism.

145. Electricity in Incontinence of Urine.—Capriati (Edinburgh Medical Journal) records a case of involuntary enuresis successfully treated by means of the currents introduced into medicine by Morton, of New York. These are known as induced static currents, and are furnished by the oscillatory discharge of Leyden jars connected with an electrical machine. The patient is not insulated, but is connected with one of the jars, while the other is connected with the earth. The intensity of the current is regulated by merely altering the distance between the discharge-rods. Capriati's patient was a previously healthy man of 35, who was gradually attacked by weakness and wasting in the left leg, with clubfoot, and exaggerated knee-jerk on that side. There was no reaction of degeneration, but incontinence of urine was very troublesome. The author considered the symptoms to point to limited lesion of the spinal cord in the lumbar region. After several experiments with different currents, Morton's currents were used in conjunction with the spinoperineal galvanization. Immediate relief followed, and after the treatment had been carried out every other day for 2 months, cure was complete as regards incontinence.

VESICAL AND URETERAL CALCULI

146. An early diagnosis, which can be made by the employment of the Roentgen rays, is important. These calculi have been dissolved in the laboratory by electrolysis, but in the human body they needed a stronger current than is practicable. Therefore, electric treatment has been abandoned.

VESICAL SPASM

147. *Vesical spasm*, or *vesical tenesmus*, which some medical authors, by tradition, have called a "spasmodic stricture," may arise from different causes, and is often only a symptom of other diseases. If the sphincter vesicæ is thrown into spasmodic action, a retention of the urine follows. To reverse this order, it may be stated that the retention of the urine causes vesical spasm, and the question arises, Which of the two states is cause or consequence? Winckel enumerates the causes of vesical spasm as (1) neuralgia of the bladder, (2) excitements from sexual excesses or onanism, (3) colds, etc. Other causes may be sitting on cold stones or ground in damp weather, and drinking new beer, which is sold as lager beer. All urethral obstruction causes more or less retention of urine, which may be followed by spasm. Paralysis of the bladder itself, or of the spinal nerves leading or governing the action of the bladder, must necessarily cause spasm of the bladder. Paralysis of the bladder proper arises mostly from distention of the walls of the organ by the urine, which stretches the muscular coat to such a degree that the power necessary for expelling the urine is impaired or lost.

Both the galvanic and faradic currents have been successfully used in spasm of the bladder, and either may be correct, according to the cause of the spasmodic action and indications. Dr. Ernest Wende, of Buffalo, reports a case treated by galvanism as follows:*

"E. B., a strong, healthy looking young fellow, aged 25, consulted Doctor Hoddick of this city, about a year ago, for a

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*Buffalo Medical and Surgical Journal, December, 1890.

supposed deep stricture of the urethra. He gave a history of having had gonorrhea on several occasions, followed by the usual methods of treatment. One year prior to this, while in the city of Rochester, he was suddenly seized with an attack of retention.

"He immediately consulted a local physician, who advised and practiced electrolysis of the urethra, with a result that proved almost disastrous, for the symptoms that ensued became so urgent, the febrile disturbance so marked, that his parents were sent for. Subsequent to the consultation with Doctor Hoddick he again experienced retention, which the doctor succeeded in relieving by the administration of the usual hip-baths, morphin, suppositories, etc. He then left town for a few months, but on his return he was again seized with a similar attack. Once more the doctor was summoned, but on this occasion all antispasmodic and antiphlogistic treatment failed, nor could the accumulation of urine be drawn off by means of the catheter. However, the patient was finally relieved by aspirating the bladder per rectum.

"A few days later, at the suggestion of Doctor Hoddick, I was invited to see the case. On instituting an examination, we encountered no difficulty in passing a number of sounds, and therefore concluded that the trouble was merely spasmodic.

"Some months later the patient called me up at midnight, saying that he could not find Doctor Hoddick, and that he had just returned from Erie. He walked into my office in a stooped manner and appeared restless. He referred to pain and local uneasiness in the lower part of the abdomen. His expression was anxious, and his desire for relief urgent. He had not been able to void his urine since the previous evening. He furthermore stated that the retention was occasioned by an attack of diarrhea.

"My first thought was to employ an anesthetic and careful catheterism, when it suddenly occured to me that the pathological significance of the reflex irritation in its bearing on retention might be relieved by electricity. This I found to be true by placing one electrode, the positive, on the perineum,

the other, the negative, above the pubis, over the bladder. The current employed was the galvanic, the dosage 20 milliamperes, and the length of application 5 minutes.

"Immediately, the urethral spasm became supplemented by a copious flow of urine, of a dark color and a strong odor. The patient immediately experienced a sense of relief and exclamations of joy were frequently uttered during the process of micturition. It was a grateful mitigation of an urgent desire. It was a gratifying result. Doctor Hoddick has since had an opportunity to confirm the value of this plan of treatment."

148. Dr. H. B Stanley, of San Miquel, Cal , used faradism and reports as follows:* "Spasmodic stricture is usually caused by irritation of the urethral canal, excessive venery, sudden cold or chill to the perineum or fundament, or some nervous irritation to the lumbar or pelvic plexus of nerves. Unless relieved, it may last for days or weeks, and from being a local disease its effects may become apparent in the whole system, especially the nervous system. Spasmodic stricture may also be caused by acrid and vitiated urine. One of the worst cases of spasmodic stricture I ever saw was caused by the urine being loaded with uric acid. A week's treatment with appropriate internal remedies completely cured him, and there has been no return of the disease since, some three years ago. Immediate relief, however, was given by the use of faradic electricity, the patient holding one pole in his hand and the other being applied to a silver catheter inserted as far as possible into the urethra. When convenient, I used a urethral sound insulated to the point, which was armed with an olive-shaped bulb prepared expressly for the purpose. Usually, a treatment of 2 minutes relieved the spasmodic condition and the patient could void the urine copiously."

149. Organic stricture is an entirely different disease and requires a widely different treatment.

From these two different treatments, the lesson may be that the physician must use that current which is indicated from the

*Summary, March, 1901.

gical, but not a word is said about the use of electricity. Hence, all that can be found in the literature on the subject is omitted here, and only the methods of electricity and the instruments used by us, which are considered new, will be described.

The tumors that appear in the bladder are of different character, as enumerated by Barling, Goulson, and others. Tumors that came under our observation were mostly papillomata, myomata, and vascular (angiectasia venosa).

152. Diagnosis. The malady is suspected by certain symptoms, as pain, irritability, frequent micturition, chills, insomnia, general malaise, hematuria in intervals, sudden retention, the abnormal state of the urine, etc. However, a diagnosis can only be made with certainty by ocular inspection of the bladder. This is made by the cystoscope and endoscope. The cystoscope of Leiter is illuminated by a storage-battery, and if successful the experienced operator will see the tumor—rather a little magnified—as plainly as in good, bright daylight. The cystoscope will not always be successful, but when it reveals the tumor the diagnosis is a certainty. To verify such a diagnosis made, we also use the old Desormeaux endoscope immediately after the cystoscopic examination. If the same condition is seen as found before by the cystoscope, the location of the tumor is verified by an exact measure—how far it is situated from the meatus and how far it is to the right or left of the median line. If such a measure is taken carefully, embodied in the notes of the case, the tumor can be found again with any instrument to be employed hereafter.

We have successfully used the endoscope of Desormeaux in diseases of the urethra and bladder since 1866. In examination, it shows the parts as they really exist at the end of the endoscopic tube. The part of the bladder immediately beneath the tube can be treated with the solutions generally used, other places may be reached by changing the tube to other focus. The advantages of the cystoscope are that it gives a better light, magnifies the parts, and the whole bladder can be explored, giving at once a larger field in loco; but it serves only as a means of diagnosis. The management of either appliance needs some

practice. So far we have had the best results, and were enabled to make a positive diagnosis by employing both the cystoscope and the endoscope in succession, as also before and after using electrolysis. Other examinations for diagnostic purposes are made by exploring the bladder with a bougie à boule, or a sound, and by injection or irrigations of the bladder, in order to find the capacity of the viscus, the state of the walls, its mucous linings, abnormal contractions, and the sensibility of the patient.

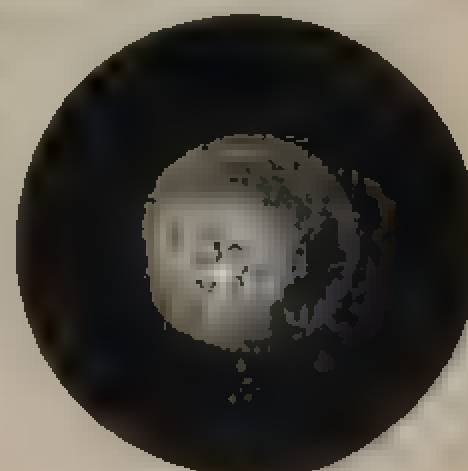

Fig. 31
Myomatous Tumor

153. Varieties of Tumors. Benign tumors in the bladder may be of different varieties, as mentioned in the text-books. Fig. 31 represents a myomatous tumor, springing from the muscular wall of the bladder, raised and standing on a wide base like an acorn-shaped body, sensitive and painful on touch but does not bleed.

Fig. 32 represents an angiectasia venosa, a chain of varix, of a dark-blue color, extending like a chain of berries in a line,

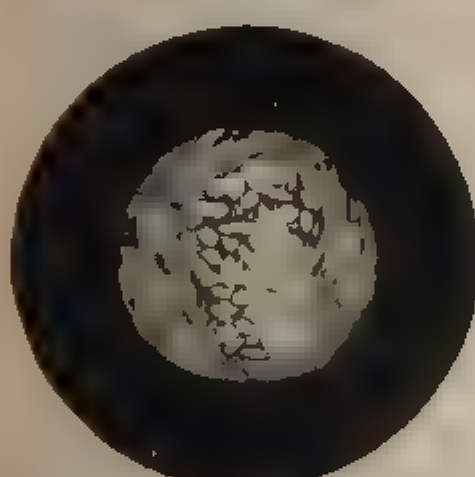

Fig. 32
Angiectasia Venosa (Before Treatment)

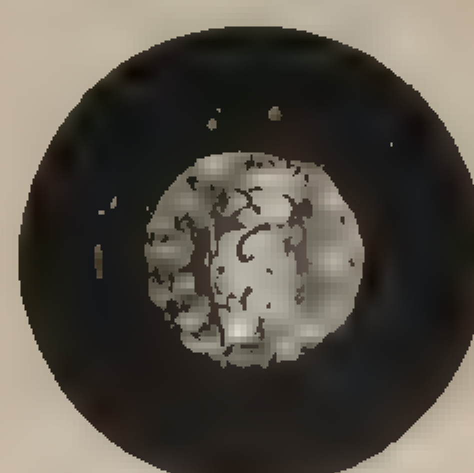

Fig. 33
Angiectasia Venosa (After Treatment)

of irregularities, stretching on the fundus of the bladder, $1\frac{1}{2}$ inches above the neck, in a transverse direction. The tumor was painful, irritable to the touch, and bled only a little at certain intervals.

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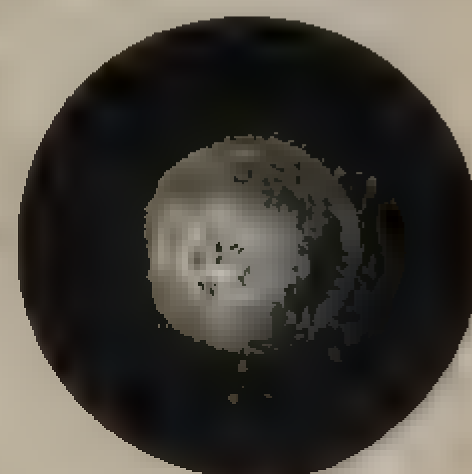

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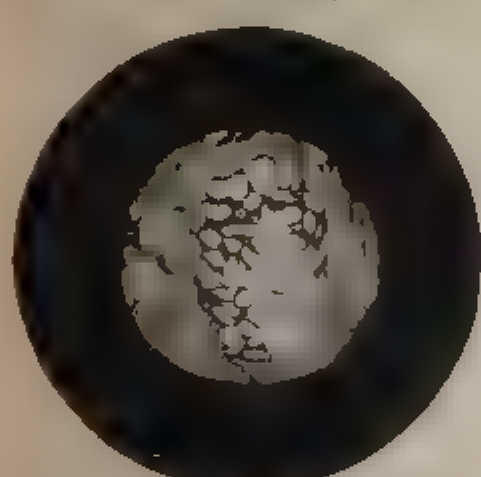

FIG. 32
Angiectasia Venosa (Before Treatment)

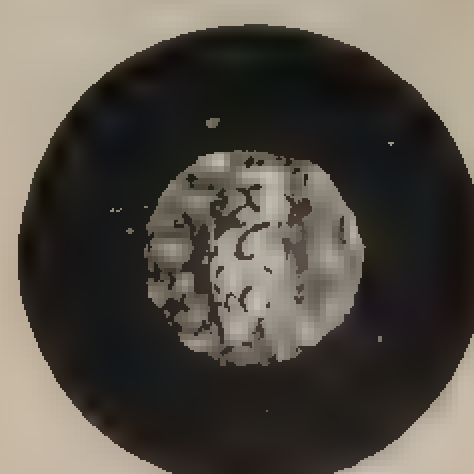

FIG. 33
Angiectasia Venosa (After Treatment)

of irregularities, stretching on the fundus of the bladder, 1½ inches above the neck, in a transverse direction. The tumor was painful, irritable to the touch, and bled only a little at certain intervals.

Fig. 33 represents the same tumor as Fig. 32, as it appeared after it had been treated a few times by electrolysis, showing a similar change as can be observed in a nævus after electrolysis has been used.

The tumors have been cured by electrolysis per urethram and therefore pathological and microscopical specimens could not be procured.

154. Treatment.—Concomitant with electrolysis, or as a preparatory treatment, measures are employed to make the patient comfortable. To allay pain, anodynes are given—best in the form of rectal suppositories and external galvanization. The tone of the bladder must be restored, and the troublesome spasms conquered. Medicated injections and washing out and irrigating the bladder succeed so well that the viscus will soon tolerate from 12 to 16 ounces, when formerly it could hold scarcely 4 ounces.

155. Electrocautery will do good service in removing the tumor by degrees. After the tumor is well located, the electrocautery-instrument is marked by a ring in such a manner that, after introduction, the platinum wire will cover the tumor in the bladder when that part of the instrument marked by a rubber ring appears at the meatus. Then, the fenestra containing the platinum wire is pressed downward against the tumor, and by pressing the current-breaker a few times on a screw, the platinum wire is instantaneously heated from a storage-battery. The instrument is almost identical to our electrocautery-sound, and only differs in being shorter and almost straight at the end. The two poles run inside an insulated tube, so that nothing will be heated but the platinum wire situated in the fenestra.

We have never failed to electrocauterize the exact place wanted, which fact was verified by an ocular inspection with the cystoscope. However, if there should be any doubt about the exact situation, the operation can be done with the place to be operated on fixated while the bladder is illuminated with the cystoscope. In the same manner, an electrocautery-sling may be used to remove a tumor at the pedicle.

156. Electrolysis may be used in different ways, but under all circumstances a galvanic battery is necessary, no other will do; or, in other words, the constant current of a galvanic battery is imperative. As a rule, the negative pole is applied to the affected part. The positive pole, in the shape of a pad or a covered carbon, is held to the palm of the hand or pressed externally over the suprapubic region. Each séance may last from 5 to 15 minutes, as indicated by method and circumstances. The strength of the current is from 5 to 20 milliamperes, an average of 10 milliamperes. The intervals of séances are governed by the result of each operation and by the condition of the patient. The first step in the modus operandi is to draw off the urine, which can be done with the urethral glass speculum, which is a very useful auxiliary, as will be shown later. If necessary, the bladder is washed out through the same glass speculum, and at least 4 to 6 ounces of clear water are left in the bladder. This water may contain a little table salt or bicarbonate soda, which facilitates the electrolytic action. In most electrolytic operations in the bladder, it is of great importance to have the bladder filled with water, and when the cystoscope is introduced, the water is needed to keep the electric lamp cool. Without the water the lamp would burn the mucous lining. After these preliminaries, each electrode is applied in its place and the electrolytic action begins, the current being gradually increased from zero to the desired strength.

157. Different Methods of Electrolysis.—There are principally two methods, general and localized.

1. *General Electrolysis.* — General electrolysis is accomplished by holding the electrode bulb in the water that fills the bladder, without touching the tumor. The electrode, Fig. 34 (*a*), is insulated except at its extremities. One extremity has an olive-shaped metal bulb, which is introduced as the negative pole per urethra into the bladder and held beneath the water without touching the tumor. The positive pole, in the shape of a pad, is held in the hand or on any cutaneous surface, which completes the circuit. Then the current from a galvanic

battery is slowly and gradually increased to the desired strength and the electrolytic work begins—from the water to the tumor. It is surprising what good effect this general electrolysis has on the tumor and general condition of the patient. It allays pain at once, makes the patient more comfortable, and has a specific, absorbing, and healing effect on the tumor. The latter effect is slow but steady.

Other advantages of this method are, that it can be done often, in fact almost daily, or in the intervals between other localized operations, which saves time and encourages the patient, who never complains of any pain during such séance. When tumors were almost removed, but a vestige left, which scarcely could be reached locally without encroaching on the

FIG 34

sound tissue, this method of general electrolysis did such good service that the case was finally cured.

2. *Local Electrolysis*.—This is accomplished by pressing the negative pole against the tumor or penetrating the same, as follows: (*a*) electrode metal bulb in contact with tumor; (*b*) platinum needle in tumor; (*c*) fixation of tumor and platinum needle in tumor, (*d*) cannulated platinum needle direct in tumor with or without fixation. Here we have four

methods, from which one can be selected according to indications and the work to be done.

(*a*) The same electrode as described in general electrolysis is also used for this method. The only difference from the former is that the metal bulb is held against some part of the tumor and in contact with it. After a certain time, when the electrolysis has acted enough in one place, the point of the electrode may be moved to another part of the tumor and changed successively to different parts.

(*b*) This and the two following methods are made on the same principle as the electrolytic treatment of a nævus. The negative needle is introduced into the tumor and then the electrolytic action absorbs or destroys it. This electrolyzed portion shrivels, contracts, and heals, by degrees, until a healthy surface appears. The urethral glass speculum, Fig 34 (*b*), is introduced so far into the urethra that its end is near the entrance of the bladder. Into the speculum, the platinum needle, Fig. 34 (*c*), is so far advanced, that its end is near the opening of the speculum. Then, with a quick movement, both speculum and needle are pushed into the bladder, and at the same moment the needle is pushed forwards, to be left in the bladder, while the speculum is removed without discharging the water left in the bladder. Then the needle is pierced into a part of the tumor and the electrolysis used as before. Sometimes it is a little uncertain where and how deep the needle passes, and in such doubt another method may be practiced. However, an operator who has had sufficient experience will overcome such uncertainties, and, if necessary, he can see the action and location of the needle by using at the same time the cystoscope, which has been done.

(*c*) This and the next method are nearly the same in principle as the last. The only difference is a greater certainty in the location of the needle by a new instrument devised by us—the vesical tenaculum cache, Fig. 34 (*d*). This tenaculum is protected at the end by a safeguard that can be moved, and thereby leaves the tenaculum free and exposed. This tenaculum runs in a very slender stem, which, when in the urethra, occupies little space and permits other instruments to pass

alongside at the same time. The tenaculum is introduced closed; when in the bladder the safeguard is withdrawn, and the tumor fixated and held firmly by the tenaculum. Then, if the safeguard is pushed forward, the tenaculum cannot disengage itself from the tumor and has a steady hold on it. If there is any doubt about the location of the tumor, the cystoscope can be introduced alongside of the tenaculum and the latter can be seen and guided into the exact location desired. Then the cystoscope is removed and the needle introduced into the tumor, the stem of the tenaculum acting as a guide. Electrolysis is applied, the instruments removed, and, if desired, the parts may be inspected again with the cystoscope.

(*d*) For this method, another new instrument is used—the cannulated needle electrode, Fig. 34 (*e*). The needle inside the cannula is fastened by the screw at such a place that the sharp point is covered by the cannula. Then the cannula is introduced in the bladder, its open end pressed against the tumor, and at the same time the needle is pushed forwards as far as it can go. The screw is then fastened again. In this position, the needle fills out the cannula so firmly that no water can escape from the bladder and the point of the needle projects out of the cannula scarcely more than $\frac{1}{8}$ inch. If the needle is now forcibly pushed into the tumor, it cannot penetrate farther than $\frac{1}{8}$ inch, and therefore cannot do any harm. If it is desirable, either the tenaculum or the cystoscope may be used at the same time However, there is scarcely a necessity for doing so, as we always found the exact spot to be penetrated, which was verified by a subsequent inspection with the cystoscope. This instrument proved to be invaluable for diagnosis and treatment in these cases.

The new instruments here demonstrated have contributed greatly to the success of the operation. These instruments have been devised by us as necessity required. In most cases, it will be necessary to use both local and general electrolysis, the method to be selected according to indications.

158. Conclusions.—The following conclusions have been derived from what has been said in regard to treatment of

tumors of the bladder: (1) Tumors in the bladder of the male can be treated by electrolysis, but in most cases it will be preferable to perform suprapubic cystotomy and remove the tumor by electrocautery, electrolysis, or the knife for a radical cure. (2) A galvanic battery only must be used. (3) All operations have been made per urethram without any assistant, anesthetic, pain, or detention from business, coming and going as they pleased. (4) The result has been very satisfactory, patients acknowledging a cure, and in some cases reliable physicians having made an examination and pronounced the patient cured. (5) While the result has been favorable, it is not asserted that electrolysis will cure all benign tumors of the bladder.

DISEASES OF THE PROSTATE

159. The *prostate* is a musculoglandular organ situated at the posterior part of the urethra, lying in front of the neck of the bladder. Its physiological function is to secrete a fluid, which forms a part of the ejaculated semen, and is therefore very important in coition and fecundation. Its function is wholly sexual. The diseases of the prostate are described as atrophy, congestion, abscess, calculi, follicular prostatitis, neuralgia, gonorrheal prostatitis, prostatitis, and hypertrophy. For a practical consideration in the present subject only the last three need our special attention.

GONORRHEAL PROSTATITIS

160. This is a complication of posterior urethritis. The gonorrheal inflammation extends from the anterior to the posterior urethra, and in many cases this extension is caused by the treatment, and mostly by the injudicious use of strong, irritant injections. In such cases, the application of a solution of argonin may do good and free the parts of the gonococci; then local application to diseased parts through the urethroscope will improve the mucous linings; and, lastly, high-frequency currents may be given with a metal sound introduced

into the diseased part. Lately, several apparatus for high-tension, high-frequency currents have been invented. A metal sound, insulated except 3 inches of the lower extremity, may be applied to the diseased prostate, the other electrode, as a pad, being held in the palm of the hand or over the region of the bladder and then high-tension currents given.

PROSTATITIS

161. *Prostatitis* may appear at any time in life, but occurs generally in young men or in those of middle age. It is an inflammation that has progressed from an acute to a chronic stage. It may result from sexual excesses and sexual perversion, particularly masturbation, unskilful use of the catheter, violence, the use of caustics, or of strong injections in the deep urethra, and as a result of gonorrhea. The principal symptoms are soreness and severe pain extending in all directions. This pain is of a dull, aching character, which is aggravated by the touch of any instrument inserted for the purpose of investigation or treatment. It is referred to the perineum, rectum, urethra, and bladder, even to the suprapubic region and the pelvis. Urination causes scalding, and coition and ejaculation are so painful that intercourse is made almost impossible. Epithelium appears in the urine as flocculi or thin shreds. Hypermia of the parts can be seen on endoscopic examination, which often causes bleeding. Complications occur in adjacent parts, and manifestations of a general neurasthenia may ensue.

162. The treatment should first be directed toward allaying pain and irritation before radical measures for cure can be commenced. Irrigations of hot water, simple or medicated, are very important. It is best to use a siphon-arrangement with a nozzle not longer than 1 or 2 inches. The water-receptacle should be placed sufficiently high, so that the fluid will be propelled by gravity, and thus no instrument will be in contact with or irritate the hyperemic portion. Anodyne suppositories should be employed, and ointment of a similar kind should be

injected into the urethra. Benzoinol with cocain deserves particular mention. When the painful irritation has subsided, we have often effected a cure by local galvanization. The electrode must be introduced with great gentleness and must not be pushed onward while contact with the prostate gland gives rise to pain. The galvanic current must be mild, from 3 to 5 milliamperes. The electrode in the urethra should be connected with the negative pole, while the positive pad-electrode is held by the patient. Sometimes it may be well to begin with high-tension currents as an analgesic. We object to the local application of nitrate of silver, which generally over-stimulates the parts and thereby makes matters worse. Any treatment requires time, care, and patience on the part of the surgeon and the patient, and if such is exercised the result will be a cure. Hygienic measures and rest must be insisted on. Surgical interference has been recommended, the consideration of which must be omitted here on account of limited space.

HYPERTROPHY OF THE PROSTATE

163. *Hypertrophy of the prostate* differs from prostatitis in that it is a disease of advanced age and is not painful. The prostate is scarcely sensitive to the touch. The enlargement acts as a mechanical obstruction to the bladder, which prevents a free flow of urine. Cystitis develops with dilatation of the muscular walls of the bladder and causes frequent micturition and often retention. Other sequels of the obstruction to the passage of urine are ureteritis, with dilatation of the ureters, pyelitis, and pyelonephritis.

The enlarged prostate obstructs the free flow of urine. Its action is mechanical. The mechanical obstruction to the free flow of urine causes dilatation of the bladder and ureters, congestion of the neck of the bladder, and frequent micturition. To produce the other complications of enlarged prostate, namely, cystitis, ureteritis, pyelitis, and pyelonephritis, infection is absolutely necessary. The cause of these latter complications in the great majority of cases is the introduction of pyogenic organisms by the catheter. In making electrical

applications to the prostate, therefore, aseptic surgical technique should be rigorously observed. A large majority of these sufferers succumb prematurely.

No rational treatment has thus far been adopted for the cure of this disease. Volumes have been written on the subject. Various methods have been suggested for the amelioration of the trouble, and for the allaying of actual pain. Cases have been reported as cured, either by injections, destruction, incision, enucleation, or prostatotomy, etc., but no successful method of cure has yet been determined.

164. The great importance of establishing a method for the *radical* cure of the enlarged prostate no one can gainsay. The physician must make a correct diagnosis, and select the remedy from the different methods, which have been employed and which will be here explained. The electric treatment, according to the currents used, may be subdivided as follows:

(*a*) *Electrocautery.*—(1) The slow method of flashes by Newman's electrocautery-sound. (2) Bottini's method in one séance. (3) Modifications of Bottini's operation. (4) The radical cure by operation—cystotomy—and the removal of the hypertrophy by electrocautery.

(*b*) *Electrolysis.*—(1) Electrolysis by mild currents per urethra or per rectum. (2) Massey's operation per urethra and rectum with strong currents. (3) Electropuncture per rectum.

(*c*) *Static Applications.*—Wave-current per rectum.

(*d*) *Cataphoresis.*—By Iodin. For years the author has applied the electrocautery-sound by rapid flashes without creating a cauterization.

ELECTROCAUTERY

165. Newman's Electrocautery-Sound.—This instrument was presented and demonstrated at the Ninth International Congress held in Washington, D. C. The electrocautery-sound, Fig. 35, is a catheter-shaped instrument with a short curve at one end, and is made of smooth, polished metal. Near the tip of the curved end is a fenestra in which is placed the platinum wire

that constitutes the burner. A serpentine form is best for this wire; each end is firmly attached to one of the two copper rods inside the tube *h* and represent, respectively, the positive and negative poles. The other end of the instrument is straight and forms the handle, in which commence the copper rods, each of which is fastened to one of the pins or heat-conductors *d* and *d'*. These two pins are connected with two electric cords by binding-screws. The other ends of the two electric cords are fastened, respectively, to the positive and negative poles of the battery. The current-breaker *b* is movable, and when set straight and pressed firmly down to the screw *c* the current is closed and the burner *e* instantaneously heated.

The improvements consist in (1) having the handle in one light, convenient piece; (2) having the current-breaker under the immediate control of the index finger; (3) having the

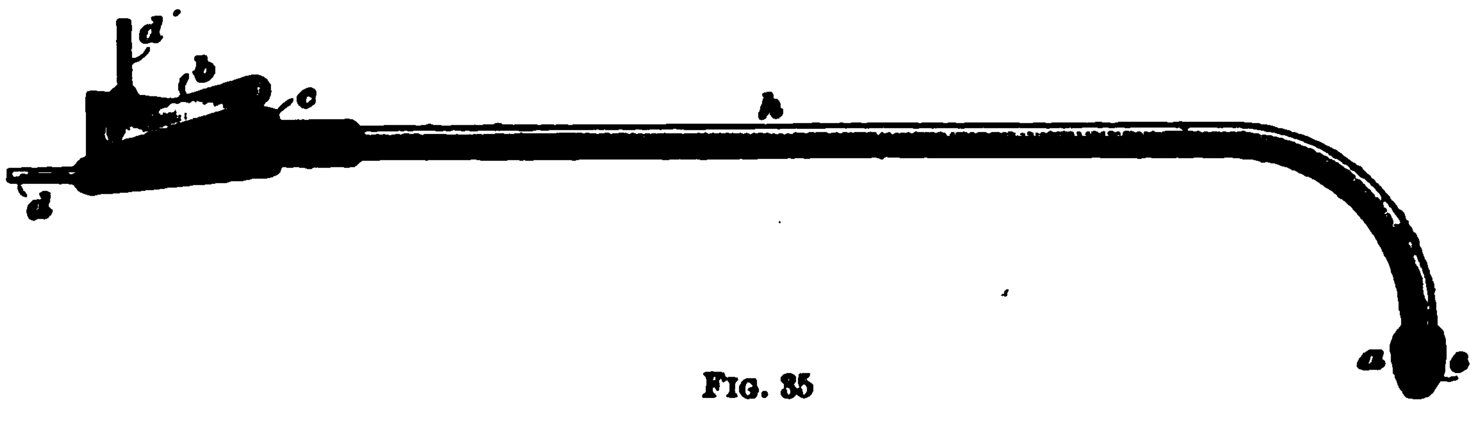

FIG. 85

Newman's Electrocautery-Sound

a, Fenestra, Inside of Which is the Burner. e, Platinum Wire. h, Tube. d and d', Pins to be Connected With the Electrode Cords. b, Current-Breaker. c, Screw to be Connected With Current-Breaker b

fenestra filled up, whereby the instrument is more thoroughly insulated and less liable to become heated; (4) having the tube filled up, thus preventing it from getting wet or blocked with débris inside.

Any good storage-battery or electrocautery-battery constructed to give a certain amperage can be used. The strength of the current should be determined with a rheostat before every operation. The heat must be of a high, red color, just short of white heat, the instant the current-breaker is touched; this heat must be kept while the wire is in contact with the mucous lining.

166. It is a mistaken idea of many that the electrocautery necessarily burns, destroys, and is followed by cicatricial tissue. This is a favorite objection made by those not acquainted with the use of electric currents. If the operator bungles or wishes to destroy, he can, but the expert will not.

It is well known that eminent neurologists apply the electrocautery directly to the faces of young ladies without even causing marks. All depends on the manner of application. Even deeper applications on mucous linings may cauterize, without destroying. Voltolini, Carl Michel, Shurley, and Yemans of Detroit, and many others, have applied the cautery to the nasal and pharyngeal cavities with great success. Therefore, it is evident that different methods can be instituted with the instrument and applied for various purposes to different parts.

167. Application to the Enlarged Prostate.—Patients suffer more or less from this disease. They may be perambulant or in bed, or may divide their time between bed and room; the hypertrophy may be small or extend to the size of an egg, or even an orange. Complications and pain may be beyond endurance to the sufferers. According to the state and circumstances the treatment must be selected and the method applied.

The slow (regular) method, which has done good service, consists in giving the enlarged gland only a short application, from an instant to 3 seconds' duration. This causes nothing more than a white film similar to the effect of nitrate of silver, in the treatment of Desormeaux.

168. Modus Operandi.—The instrument is connected with the electrode wires, which are then attached to the battery, having all the apparatus in perfect order. When all is ready, try the instrument with a short flash, which experiment excludes any possible failure. The prostatic portion to which the cautery is to be applied must have been examined, and the distance from the meatus measured. This distance is then marked on the instrument by a small rubber band. The patient, according to his preference, may stand erect, be on an

operating table, or in bed. The instrument is then introduced, so that the fenestra with its platinum wire is in contact with the part to be cauterized. The operator will know by touch when the instrument is in the right place, and the measure will corroborate the correctness of the observation. One hand holds the instrument and then touches the little spring to connect the interrupter, a flash follows, and the finger disconnects the current. In one moment, the operation is done and the instrument is withdrawn.

It causes no pain, and in some instances the patient scarcely believes that anything has been done. He is able to walk about and is not detained from business. The séance should be repeated in about 3 days, or even in 2. The instrument must be kept scrupulously clean, as the cautery will fail, if there is dirt between the connections.

169. The question now arises, How does this method bring about a cure? The end sought is, first to remove the obstruction so that the bladder can discharge all the urine at regular intervals, and then, in order to make the cure radical, to reduce the prostate to its normal size. The theory is that the cautery first acts as a tonic and next as an astringent; the diseased mucous lining shrivels, the glandular tissue contracts, and, by shrinkage, the size is diminished. The stimulation gives new life and healthy action. Each repetition of the operation acts similarly and perhaps on another part of the hypertrophy. The operation must be continued until the cure is effected. Care must be taken not to overstimulate and cause prostatorrhea, acute prostatitis, etc., thereby creating or aggravating the very ailment we seek to cure. The cautery must be given just severely enough to accomplish the object and no more. If the cauterization is too prolonged and too deep, the glandular action is overtaxed and weakened and will be followed by a prostatorrhea, which takes a long time to cure. At the same time, an inflammation is created, which causes pain and swelling, and, at last, the too greatly cauterized tissue will slough.

The advantages of the electrocautery over the knife are: (1)

that it avoids hemorrhage, also secondary hemorrhage; (2) it leaves no raw surfaces exposed; (3) it heals better; and (4) it avoids infection. The statement of some reports, that in prostatotomy with the knife hemorrhage does not take place cannot be accepted, as the history of cases shows that primary as well as secondary hemorrhage does occur, both of which are entirely avoided with electrocautery. In treatment of the enlarged prostate by electrocautery, it is absolutely necessary to pay attention to other symptoms and troubles of the patient, according to established principles. Pain must be allayed. The bowels must be kept regular, since constipation adds considerably to the inflammation and, by pressure, causes pain. While the electrocautery process is used it is of the greatest importance to attend to the state of the bladder, by drawing off the urine, and irrigating if necessary.

170. Bottini's Operation.—The originator of this method has successfully operated upon many hundreds of cases and kept them modestly to himself, only once in a while giving a report in Italian medical journals. This operation is a rapid electrocautery with a platinum burner in one séance. It consists in burning a passage through the enlarged gland by the electrocautery, thus enlarging the passage and removing the obstruction. The burner is made of heavy platinum encased in an instrument resembling a lithotrite. The burner is heated until red, or even hotter, by an electric current from a storage-battery, and by a screw it is slowly advanced through the obstruction. Antiseptic precautions are advisable, particularly of the bladder. It is still a mooted question whether the bladder should be dilated with air or water. A local anesthetic to the prostate portion of the urethra is absolutely necessary, cocain being preferable. Some patients may choose ether narcosis. Several incisions forward and backward may be made if the operator finds such a procedure necessary.

171. Attracted by the first reports of this operation, we performed it several times. The late Doctor Guleke, of New York, had imported an original Bottini instrument with which we operated. These operations were performed in 1882 and

1883, but were not satisfactory. This fact explains the incorrect statements of recent reports in 1897 and 1898 to the effect that the Bottini operation had never been performed in this country. Not having had the expected result with the Bottini instrument, we constructed the electrocautery-sound just described. While the genius of Bottini is appreciated and admired, his first instruments were not perfect, particularly in the points as follows:

1. The instrument was clumsy, unhandy, and heavy.

2. The platinum burner was so thick that it got hot too slowly and, when hot, lost its shape by bending so that sometimes it would not move back into its beak.

3. The very large storage-battery was too heavy for transportation and a smaller one did not generate enough heat.

4. The instrument was shaped like Heurteloup's lithotrite, the ends having only a short coudée. Such an instrument is exceedingly difficult to introduce, and in many cases of hypertrophy non-introducible, the mechanical obstruction leaving no space for its passage. The intention is to push the instrument into the bladder over and beyond the enlargement of the prostate, then to reverse it so that the beak is turned downward. The electrocautery-knife is hidden inside the beak and moves outward when the dial is turned on the handle as the battery heats it, thereby making a central cut in the obstructing prostate.

5. The result of this operation was very uncertain. It sometimes caused shock, pain, and inflammation and irritated the bladder, and the exfoliation of the scabs caused by the cautery gave rise to more complications. It may be again stated that the effect of the electrocautery is really a burning through the tissues, being entirely different from electrolysis, which is a chemical absorption.

6. The patient had to remain in bed for weeks, and from some reports made by Bottini himself it has been shown that voluntary micturition occurred only after 24 days.

7. The operation is not free from danger.

These objections refer only to the old original instruments. Recent modifications have been made.

172. Modifications of Bottini's Instruments.—A modification of Bottini's apparatus was made by Freudenberg, of Berlin. This device, Fig. 36, is a great improvement and does away with some of the objections experienced in former times. Freudenberg describes his modification as follows: "The modifications in point are relative to shape, handiness, and electrotechnical construction, affording at the same time the possibility of sterilization. The modified instrument is provided with a stout cylindrical, grooved handle, strong and steady in the hand, resembling the well-known handle of a lithotrite. The cooling-apparatus is inserted on this side of the handle instead of at its farther extremity, thereby obviating incandescence of the handle and securing the rubber hose of the cooling-apparatus from being compressed by the ulnar aspect of the hand. In lieu of the platinum blade, platiniridium is used, this alloy being harder and less apt to bend by reason of its electrical resistance, permitting the employment of the weaker current for rendering the blade incandescent. Another addition consists in the conduction of the current, ascending to the knife, within the guide through a single wire only, which equals in volume the two wires used in the original instrument; the descending current passes through the hull proper, and by reason of its close contact with the cannula, through the entire length of the external instrument. Moreover, greater steadiness of the blade, riveted as it is to the inflexible hull, is assured.

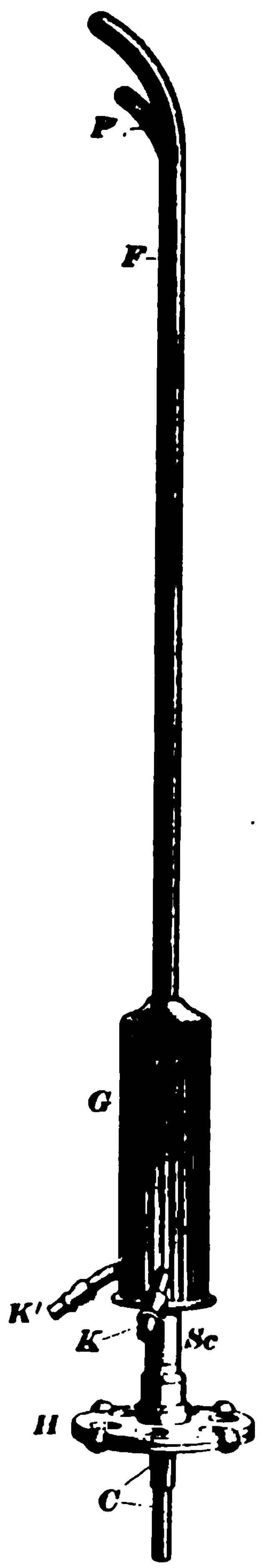

FIG. 36

"The connection of the instrument with the conducting-wires has been achieved by a process corresponding with the axis of the instrument and leaving both poles in a concentric arrangement. A slight jerk will move up the corresponding cable-attachment to which the

cables are fastened; these are united to one conducting-wire, and owing to the improvement of electrical construction are much thinner than formerly."

173. The operation of Bottini has been described as "one of detail." This is undoubtedly true, yet from a practical point of view it is just as true to state that it is an operation of a few important factors. These factors are: (1) The condition of the bladder, whether empty or containing a certain quantity of liquid or air. (2) The length, depth, and number of incisions. (3) The complications that have been brought on by the enlarged prostate or by previous efforts to remedy the enlarged prostate gland. (4) Reliable working-apparatus.

Bottini's first operations were performed on a bladder filled with liquid. Later, he operated on an empty bladder, because he thought the liquid in the bladder interfered with the heating of the cautery-incisor. At the present time, the operation is always performed on a bladder containing either liquid (usually a sterilized solution of boric acid) or air. Bransford Lewis recommends the injection of air into the bladder. Lewin-Goldschmidt has pointed out, as a result of experiments on animals, that in injecting air into the bladder there exists the possibility of an air-embolus entering the ureter and reaçhing the heart through the renal veins and inferior vena cava. Freudenberg reports 43 operations on bladders containing air with no untoward results so far as injecting air was concerned.

At the present time, no one operates on an empty bladder, the viscus containing either air or a solution of sterilized boric acid. The possibility of an air-embolus entering the ureter should have considerable weight with the operator, particularly as there is no such complication to be expected when using the sterilized boric acid. With the modern sources of electric supply, the objection made by Bottini, when using liquid in the bladder, is no longer tenable. The cautery-incisor can now be maintained at the required degree of heat during the passage through the prostate gland. In operating on an empty bladder, Freudenberg cut through a transverse fold of the fundus of the bladder. Some operators claim that the burning sensation

experienced by patients during the operation is due to the heating of the sterilized solution of boric acid by the cautery-incisor.

174. Length, Depth, and Number of Incisions. The cautery-incision or incisions constitute the pivotal point in every Bottini operation. They constitute the raison d'être of the operation. Whether the operation shall be repeated or not depends entirely on the dimensions and number of the incisions. To make a posterior incision too short means an unsuccessful operation and carries with it the necessity of repeating the procedure at some subsequent date. To make a posterior incision too long means an internal urethrotomy through the floor of the membranous urethra with its well-known sequences as a result. Three incisions are generally made, one posteriorly and one on each side. The posterior incision is by far the most important. The success of the operation depends in a large measure on the posterior incision. If successfully executed, it lowers the level of the bladder drainage, the prostatic urethra to the level of the base of the bladder, and permits a free flow of urine through the furrow produced by the cautery-incisor. It secures a direct route for the urine, from the center of the bladder through the anterior urethra. This posterior incision, and also the lateral incisions, diminishes the blood-supply to the prostate and therefore causes atrophy. Another effect of these cautery-incisions is to prevent recurrent congestions of the neck of the bladder that mean so much in the life of every prostatic.

The anterior incision is never employed unless cystoscopy shows the mechanical obstruction to exist in the anterior aspect of the urethra. The anterior incision is dangerous. The liability to cut into the cavum Retzii with its consequences should be remembered when making an anterior incision. The depth of the incision will depend on the height of the incisor and the pressure exerted on the prostate gland. The average height of the knife used by Freudenberg is 1.2 centimeters. The sizes of his knives vary from .8 to 1.5 centimeters. The height of the knife of American instruments averages from 1.2 to 1.5 centimeters. A difference of a few millimeters in the height of a knife can be fully compensated for in the depth

of the incisions by pressure made on the gland by the operator. In determining the depth of the incision, the operator studies the configuration of the prostate gland by means of the cystoscope and also by rectal examination. If necessary, the knife is made to pass twice through the same area in the prostate gland, and during both incisions it should be maintained at a white heat. With one knife of average height maintained at white heat and passed twice through the same area of prostate tissue while pressure is being exerted, the operator can give his incision the required depth.

175. The length of the incision will depend a great deal on the nature of the enlargement, whether it is fibrous or glandular. A fibrous enlargement is slightly compressible; a glandular one is very much so. As a rule, the length of the posterior incision in fibrous prostates should correspond to the difference between the normal urethra and the pathological one under treatment. If the urethra in question measures 28 centimeters, we know the normal urethra measures 21 centimeters, and the length of the incision should be the difference, or 7 centimeters. When the length of the incision is determined by rectal examination, 1 or 1.5 centimeters should be added to the longitudinal diameter of the prostate. Freudenberg has not yet found it necessary to make incisions larger than 5 centimeters. His new instruments are arranged to permit of an incision 6.6 centimeters long. When glandular elements predominate in the prostatic enlargement, the conditions are entirely changed. Glandular enlargements are very compressible. When the beak of the incisor begins to press on the gland, the longitudinal diameter begins to decrease at the same time. Willy Meyer, M. D., has pointed out that the simple means of measuring the length of the prostate in his cases is of little assistance in determining the length of the incision necessary in a given operation.

The same author now uses an incisor that permits of incisions as long as 8 centimeters and recommends long incisions under the following conditions: (1) When the enlargement is fibrous and pronounced, so that the upper border of the gland

cannot be reached or palpated per rectum. (2) Whenever there is a median lobe of some size present. (3) Whenever the length of the urethra has been found to be materially beyond normal.

When the prostate is soft and compressible, he recommends short incisions, not longer than 1 to 2 centimeters. It is better in cases of soft, compressible glands to make an incision too short, rather than to take risks in making one too long. In this latter case, the pars membranacea would be incised, followed by urinary infiltration with its accompanying dangers. In determining the length and depth and number of incisions in the prostate gland, the operator should use every means of informing himself on the diameters, configuration, and consistency of the gland. He should make a thorough examination per urethra and per rectum. Unless contraindicated, the cystoscope should be used.

176. The Bottini operation is suitable for all forms of prostatic hypertrophy. An enlarged prostate is an impediment to the passage of urine, and a cautery-incisor will cut its way through this impediment, whether hard or soft and whether situated posteriorly, anteriorly, or laterally. It is of little importance, also, whether the bulgings or prominences are toward the bladder or exclusively toward the urethra.

The results of the Bottini operation, however, in any form of prostatic hypertrophy will depend on the condition of the bladder and kidneys and on the general physical condition of the patient. The better the condition of the bladder and kidneys, the better will be the results of operation. The results of the operation will be negative when the bladder is hopelessly damaged and when there is a general atheromatous condition of the blood-vessels associated with polyuria.* In prostatic hypertrophy, the earlier the operation is performed, the greater are the chances of a permanent cure. Convalescence in these cases is very rapid, and the results obtained so far as can be ascertained at present are permanent.

*Orville Horwitz, B. S., M. D., Philadelphia Medical Journal, June 22, 1902.

Willy Meyer, M. D.,* recommends that the Bottini operation be done when it becomes necessary to give the catheter into the hand of the patient himself. This is the period at which the real danger of life begins. A single introduction of the catheter may set up incurable cystitis, pyelitis, or pyelonephritis. Bottini's operation, according to the same authority, is not absolutely contraindicated by the existence of pyelitis. In two cases operated on by him, a marked degree of pyelitis was present. Both patients stood the operation nicely, one being cured and the other much improved. The fact of the existence of an infected genito-urinary tract should render the operator very cautious in his prognosis in these cases.

177. Armamentarium.—If the physician provides himself with a transformer, a good rheostat, and ampere-meter, the commercial circuits may be used as sources of electric supply. When the commercial circuits are not available, a good storage-battery must be employed. The storage-battery should give from 50 to 60 amperes with an electromotive force of 4 volts. For care and management of storage-batteries, see *Electrophysics*, Sec. 1. Freudenberg added the ampere-meter to the armamentarium of Bottini. The flow of the cautery-current is noiseless; therefore, the necessity of an ampere-meter to designate the current-strength during the operation is obvious. The current-strength necessary to bring the cautery-incisor to the required heat should be determined before each operation. When the cautery-incisor is at a white heat, envelop it in a few layers of absorbent cotton saturated with water and observe the effects both on the incisor and the needle of the ampere-meter. This is a useful experiment and renders visible to the operator what takes place when the incisor is traversing the tissues of the prostate.

178. With a single charge of a storage-battery, Freudenberg performed six operations. Storage-batteries, even when not used, run down and require charging every 3 or 4 weeks. It is a good rule to recharge the battery before each operation.

*Willy Meyer, M. D., Medical Record, April 28, 1900.

Two or three operations may be done on the same day with the same charge, but if a few days intervene between operations, recharging the battery will always be the safest procedure. The operator should examine the Bottini incisor and all its connections before the operation, in order to be sure that everything is in good working order before commencing to operate. As some accident may happen to the incisor either immediately before or during the operation, the advantage of having two cautery-incisors will be readily appreciated. Besides the source of electric supply and the Bottini incisor with its connections, the operator will always need hand-syringes, catheters, local anesthetics, and antiseptics.

In the operation of Bottini, the practical genito-urinary surgeon will be occupied a great deal with the electrical apparatus; the practical electrotherapeutist, already familiar with the management and control of electric currents, will be most occupied with the technique of genito-urinary operations. A nice combination of these two acquirements—familiarity with the technique of genito-urinary operations and familiarity with the management and control of electric currents—are necessary for the best execution of Bottini's operation, and therefore the best results obtainable.

179. Complications During and After Operation. The complications during the operation are the bending of the cautery-incisor, perforation of the bladder, and perforation of the membranous urethra. In order to prevent bending of the cautery-incisor, the operation should be done slowly and the index finger should be removed from the rectum when the beak of the incisor is properly located and before the cautery-current is turned on. The patient should be cautioned to keep absolutely quiet during the operation. If the Bottini incisor is not held firmly and steadily in the left hand of the operator, bending of the cautery is liable to occur. The means of avoiding bending of the cautery-incisor are slow operation with the cautery-blade at white heat and immobility on the part of the patient. The incisor is held firmly and steadily in the hand of the operator.

The liability of perforating the membranous urethra is greatest in glandular enlargement of the prostate. A short incision is required in these cases. A careful study of the longitudinal diameter of the gland and of the nature of the prostatic enlargement, whether glandular or fibrous, will be the best safeguard against perforating the membranous urethra. If the incision is made too short, the operation may be repeated at a future date. Since operation on an empty bladder has been discarded perforation of the bladder has not occurred. If the beak of the incisor is properly fixed behind the prostate, it will press the bladder downward from the cautery-blade. This precaution joined with the condition of the bladder, distended with liquid or air, will make perforation of the bladder an extremely rare accident.

The complications after the operation are hemorrhage, sepsis, and retention of urine. The prevention and treatment of these complications belong to general genito-urinary work and will not be described here. No one should attempt to perform the Bottini operation unless he is familiar with the best methods of preventing the occurrence of these complications and of treating them when established. The operation of Bottini, even in favorable cases, is a serious procedure. The patient should be thoroughly prepared for the operation by the observance on the part of the operator of all precautions of modern surgery.

180. Anesthesia.—The majority of operators employ local anesthesia. If it becomes necessary to give a general anesthetic, nitrous-oxide gas is used.*

Orville Horwitz, B. S., M. D., in a series of articles recently published,† gives the following conclusions as the results of his experience in 34 Bottini operations:

1. There is less fear on the part of the patient to submit to operation than there is to any other surgical procedure so far suggested for the relief of prostatic hypertrophy.
2. The principal advantages to be derived from the method

*Ramon Guiteras, M. D., New York Medical Journal, April 29, 1899.

†Philadelphia Medical Journal, June 8 and November 30, 1901.

of treatment are: A short time only is required to perform the operation, which is attended with little shock and usually slight loss of blood; convalescence is rapid; and the mortality is lower than that by any other radical measure.

3. Cures result in a large majority of cases, especially if the operation is undertaken early. Marked improvement may be looked for in a vast number of cases where otherwise individuals would be condemned to suffer, as the danger attending any of the other radical methods of treatment would be too great to warrant their employment.

4. Failures occur in but a comparatively small percentage of cases, want of success being due to pathological changes and complications that have taken place. Especially is this true in those instances where an incurable cystitis exists.

5. The operation is contraindicated when a valve-like formation exists, or where there is a greatly increased overgrowth of the three lobes associated with tumor formation, giving rise to a pouch above and below the neck of the bladder.

6. It may be employed with benefit and safety as a palliative measure in cases of prostatic hypertrophy of long standing associated with cystitis, when the general health will be improved and constipation, which is usually associated with this condition, relieved, mitigating the prostatic spasm of the urethra and rendering the insertion of the catheter easy and painless.

7. Pyelitis, when present, adds greatly to the danger of the operation, but is not always a contraindication to its employment.

8. The character of the growth has but little bearing on the result of the operation.

9. The operation may be employed as a safe and satisfactory means of causing a suprapubic fistula to close, which so frequently follows a suprapubic cystotomy when the prostate gland is hypertrophied.

10. In suitable cases, it is not only the best radical measure thus far devised for the relief of prostatic hypertrophy, but is attended by the smallest mortality.

11. The operation is especially indicated in the beginning of obstructive symptoms due to hypertrophy of the prostate gland and may be regarded as a prophylactic method of treatment.

12. The operation is capable of producing a symptomatic cure in a great number of cases of various conditions and configurations of the prostate gland due to hypertrophy, as is shown by the disappearance of prostatic spasm, the restoration of the function of the bladder to its normal condition, and the improvement of general health.

13. When operating early, before the prostate has become much enlarged, the safest method to pursue is to perform a preliminary perineal cystotomy, introducing the perineal electro-cautery-incisor of Chetwood, so as to make the incision in the prostate.

14. In some instances, a prolonged preparatory treatment is necessary before the operation can be safely undertaken.

15. In cases of prostatic obstruction, which have existed for a lengthened period, where there is chronic cystitis and the physical condition of the patient being below par, both local and constitutional treatment must be persisted in for months after the operation before the great benefit derived from the procedure can be insured, which treatment would be ineffectual unless the obstruction had first been removed.

181. Newman's modifications of Bottini's instrument has been constructed for reasons stated, as a simpler and handier

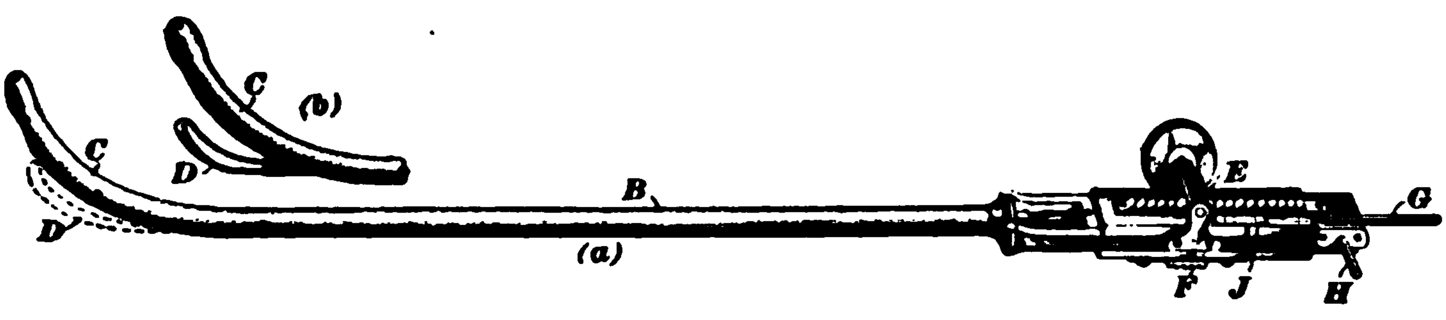

FIG. 37
Newman's Modification of Bottini's Incisor

apparatus, than the modification of Freudenberg, which is very good, timely, and rectifies some of the objections mentioned.

Fig. 37 (*a*) shows the instrument in perspective, with platinum burner, shown in dotted lines, slightly exposed. (*b*) is the end of the instrument with the platinum knife fully exposed. The instrument consists of a hollow metal shaft *B*, terminating in Thompson's curve with tunneled end *C*. The platinum

knife D is propelled backwards and forwards by means of a rack and pinion E. Two insulated copper wires pass through the shaft and carry the electric current to the platinum burner. The conducting-cords from the battery or commercial circuit are adjusted to the instrument at staples G and H. The current may be thrown on or off by means of the switch F. A scale and indicator J shows at a glance the extent to which the knife is exposed. Freudenberg's improvement on the original Bottini are very good and were needed. On this improved instrument, the writer has made the following modifications, as shown in the cut:

1. Omitting the water-cooler, in order to make the mechanism of the instrument simpler. The water-cooler is an impediment, takes up space, and needs for its proper management a special assistant. As the burner is smaller than in the original instrument, it does not need so much heat, and this can be controlled more easily. It has been questioned whether it is better to dilate the bladder with water or air. Each method has its own advantages and objections.

2. It is better to do away with the heat of the instrument. This is accomplished by the two conducting-wires conveying the heat, which are attached one to either end of the burner and which run separately, being insulated. This arrangement will heat the burner immediately and prevent the heating of any other part of the instrument. The shaft remains cool.

3. The end of the instrument is conical and of a smaller size, in order to pass any obstruction and enter the bladder more easily. Thus, the operation can be performed in cases in which the larger-sized portion of the instrument could not be introduced.

4. There is a tunnel at the conical end for a filiform guide, over which the instrument passes, to be used at the option of the operator.

5. The iridoplatinum burner is thinner and stationary, and thereby cannot get out of shape and place, and, besides, the greater heat is avoided.

6. The protector of the burner, when moved, acts at the same time as a meter, the operator thereby knowing the exact

situation of the burner. This burner, or knife, can cut to any depth, as the operator desires, and by rotating can cut in different directions. The instrument can be taken apart for cleaning and sterilization.

7. This instrument is cheaper and costs about one-half as much as the original Bottini or the one modified by Freudenberg.

182. Radical Measures, Combination of Operation and Electrocautery.—This consists in the removal of the hypertrophy by electrocautery in situ and in one operation, access being gained by either perineal section or laparotomy. This removal may be partial or entire, and can be done with the electrocautery-burner or wire loop. This operation is indicated, in fact, we may say peremptorily demanded, when the patient is in immediate danger of succumbing and no time is left for a slower method of procedure. This state has arrived when the hypertrophy causes absolute retention of urine and there is no possibility of gaining an entrance through the obstruction so as to evacuate the bladder. Complications have generally taken place and the fatal end is within a few hours, either by rupture of the bladder or urethra. The radical operation proposed for such a state is not free from danger, but as the patient without it will succumb in a short time, the operation cannot decrease his chances of recovery.

The improvements in the technique or suprapubic cystotomy by Belfield, Hunter McGuire, Kuemmel, Morris, and others have reduced any danger to a minimum. Mr. A. F. McGill, of Leeds, in opening a discussion at the Section of Surgery, British Medical Association, August 16, 1889, remarked that suprapubic prostatectomy was preferable to a urethral or perineal operation. The urethral operation was unsatisfactory; it was founded on the faulty anatomy, for in only 4 out of 24 cases he had tabulated was there anything resembling a bar at the neck of the bladder. The suprapubic operation was also more generally applicable; in only 3 of the 24 cases in his table could the perineal operation have been done. He also considered the suprapubic operation more safe than perineal section. Most authorities will agree with Mr. McGill.

ELECTROLYSIS

183. Electrolysis With Weak Currents.—Electrolysis has been used with favorable results, and cases reported accordingly. We have practiced it in the same manner as in strictures of the urethra and often applied a flat metal-electrode as negative pole per rectum against the prostate. With great care and very mild currents, good results followed. Dr. W. E. Steavenson, of London, has established a method and constructed his own instrument; a citation from his work* will therefore be in place here:

"For this purpose I have had some electrodes made after the manner of those used for the electrolysis of stricture, but instead of the ends being made entirely of metal, I have had them of ivory, with phalanges of metal embedded in one side, so that the metal would be on the convex surface of the ends of the electrodes. By this means, we insure that when the electrode has been passed along the urethra, the metal phalanges shall come in contact with the prostatic bar or obstructing hypertrophical part of the prostate. The electrode is connected with the negative pole of the battery, the positive pole being placed on some indifferent part of the body. The circuit is then closed and a weak current of 5 milliamperes is employed. By this means, a furrow, or groove, is made on the surface of the enlarged prostate by the action of the current. The result has been such as to encourage the hope that this may prove a very useful form of treatment. The operation should not be prolonged for more than 20 minutes, and on the first few occasions for about half that time, unless the electrode passes into the bladder sooner. Should this be the case, I would advise that all further attempts be suspended for at least a week, and then repeated if no indication to the contrary has arisen."

184. Electrolysis by Strong Currents.—While others have used stronger currents, Dr. G. Betton Massey, of

*"Electrolysis in Surgery," London, 1890, page 106.

Philadelphia, has very recently begun a new treatment of hypertrophy of the prostate gland. He calls it the "swelling method." With the electrodes in place, the active electrode within the urethra or rectum and the indifferent on the abdomen, the galvanic current is turned on by means of his controller until a decided sensation is produced or the meter shows a desirable dose, and is turned off again in a few seconds, the procedure being repeated eight or ten times. He uses as much as 70 milliamperes, though each case must be a rule to itself in this particular. As the growth diminishes, the sensitiveness of the prostatic urethra will increase until finally from 5 to 15 milliamperes will be the limit. The negative pole has been used as the active. He makes his own instruments. After each galvanic application to the prostatic urethra, the instrument should be left in place, and a primary faradic current turned on in a swelling manner. The instrument is now withdrawn and a similar application made to the exterior of the prostate by an olive-tipped electrode in the rectum, and the same electrode on the abdomen. The rectal treatment may be employed daily, and is at times efficient, but the urethral method must be used at intervals of from 4 to 7 days only. Doctor Massey reports complete cures. This method is of such recent origin that no comment can be made on it.

185. Electropuncture.—Instead of the negative metal bulb, in this mode of treatment, a needle is used and thrust into the prostate per rectum. The best needle is made of platinum, insulated to within a short distance of its point. An electrode placed on the abdomen, to close the circuit, is connected with the positive pole of the galvanic battery. Biedert, of Hanan, reported five cases in which the hypertrophy was reduced. Leopold Casper, in 1888, read a paper before the Berlin Medical Society and claimed improvement in four cases. He uses the negative needle to the hypertrophy per rectum. He claims that the method is curative and, if car fully executed, harmless.

STATIC APPLICATIONS

186. Wave-Current of the Static Machine.—Very recently the wave-current has been used to the prostate per rectum, with a bulb or an instrument constructed for this purpose. The patient must hold the electrode himself. We have tried the method with different instruments, sometimes using a bulb in the rectum, at other times a sound at the prostate per urethram. This method has been practiced very recently and only in a few cases, so that no definite report of its utility can be made.

CATAPHORESIS

187. Cataphoresis, introducing iodin into the hypertrophied prostate, has been practiced and advised by Dr. C. S. Neiswanger, of Chicago. His lecture was read before the Illinois Medical College, January 26, 1900, and published in the Alkaloidal Clinic, March, 1900, from which is quoted as follows:

FIG. 38
Prostatic Electrode for Cataphoresis

"My method of the cataphoric application of iodin to the enlarged gland is not only rational but gives promise of better success than any of the methods heretofore used, and is so simple and safe that it may be employed by practitioners far removed from medical centers."

The applicator shown in Fig. 38 is composed of a hard-rubber tube, closed at the distal end by a hard-rubber plug. For a distance of about 2 inches from the distal end, a number of small holes are drilled. The metal inside (which is removable) consists of a copper wire twisted upon itself, on the proximal end of which is soldered a receptacle for the cord-tip.

Upon about 2 inches of the end of the twisted wire a little absorbent cotton is wound, and, after being dipped into a solution of potassium iodid (30 grains to an ounce), is inserted into the hard-rubber tube. The electrode is then attached to the

negative cord from the battery and inserted into the prostatic urethra. A large pad is now attached to the cord from the positive pole of a galvanic battery, and placed upon the abdomen of the patient, when a current of from 6 to 10 milliamperes is turned on by means of a rheostat; and this may be maintained for 10 minutes without discomfort to the patient. The treatment should not be repeated oftener than once in 5 days.

A granular or irritable condition of the prostatic urethra contraindicates both the application of the negative pole and the iodin, and as this condition often exists, it should be treated by a different method as follows: Take an electrode such as is shown in Fig. 39, which consists of a copper staff insulated with hard rubber to within 2 inches of the distal end. This is introduced so that the metal portion comes in contact with the prostatic urethra only; it is then attached to the positive pole and a current-strength of 5 milliamperes used for about 6 minutes, rotating or gently moving the electrode backwards or

FIG. 39

Prostatic Electrode for Cupric Cataphoresis

forwards to prevent it sticking to the mucous membrane. The treatment may be given every fourth day.

Much conflicting literature has appeared upon the subject of cataphoresis, but as we have given our views upon this process in detail from a physical standpoint, we deem it only necessary to say here that in the above technique the solution of potassium iodid is decomposed by the current, and the iodin, being an electronegative element, has an affinity for the positive pole; therefore, the solution must be applied from the negative pole if we would utilize the resolvent effects of the iodin in the enlarged gland. The negative being the decomposing and liquefying pole, we have, therefore, both the polar effects of the current and the iodin, each of which is indicated.

The treatment of prostatic hypertrophy has changed from one extreme to the other. In former years, the patient was

condemned to use the catheter for a lifetime, which was a very indefinite period, and it generally increased the trouble. At present the condition may be attacked surgically by way of the urethra, perineum, rectum, or suprapubically. Electrical treatment has been described here in nine different methods. All will do good, are rational, and it is for the attending physician to select the right method in its right place.

IMPOTENCE

188. The normal generative act in the male includes two parts: (*a*) copulation, which depends on a perfect erection of the penis, and (*b*) ejaculation of fertile semen into the vagina. Sterility does not include impotence, and is often met with in those who are vigorous in intercourse. Sterility is the inability to get children. Impotence and sterility sometimes run very closely together, yet, as a rule, a distinction should be made between them.* If erection is wanting, there can be no ejaculation of semen into the vagina, the patient is therefore impotent and sterile also.

189. In endeavoring to assign electricity its proper place in the treatment of these conditions, we shall be guided by the results obtained by those who have devoted special attention to these subjects and also by the results obtained in our own practice.

Prof. S. W. Gross† classified impotence as (1) *atonic*, (2) *psychical*, (3) *symptomatic*, (4) *organic*. Atonic impotence is due to diminished or abolished reflex excitability of the genitospinal center; and psychical impotence, to some derangement of the brain inhibiting the action of that center. Organic impotence depends on congenital or acquired defects of the genital organs. Symptomatic impotence is brought on by the prolonged use of certain drugs, bromids, opiates, and by various acute and chronic diseases.

*Jacobson, "Diseases of the Male Organs of Generation."

†Gross, "Disorders of Male Sexual Organs."

Gross further divided atonic impotence into the following classes: (1) The erection is imperfect and of short duration, and ejaculation is frequently too precipitate, but sexual desire remains and intercourse is possible although incomplete. (2) The erection is either so feeble that intromission is impossible or it is entirely absent. As in the preceding variety, desire is present. (3) Here there is not only loss of power, but desire is also completely abolished.

In a study of 153 cases of impotence, the same author found that 149 cases were of the atonic variety, 1 was psychical, 1 was symptomatic, and 2 were organic. Of these 149 cases of atonic impotence, 137 were due to, or maintained by, hyperesthesia and chronic inflammation of the prostatic urethra, with diminution of the reflex excitability of the genitospinal center, and in the remaining 12 there was diminished or abolished reflex excitability of the genitospinal center without any prostatic lesion. Of the 137 cases due to, or maintained by, hyperesthesia and chronic inflammation of the prostatic urethra, 127 were of the atonic variety, characterized by feeble erection and premature ejaculation.

By far the largest number of cases of impotence must therefore be classed in the first subdivision of atonic impotence. There are more cases of atonic impotence with feeble erection and premature ejaculation than of impotence from all other causes combined. In 127 cases out of 153, there was diminished or abolished reflex excitability of the genitospinal center due to, or maintained by, hyperesthesia and chronic inflammation of the prostatic urethra. The necessity, therefore, of examining the urethra in all cases of impotence is imperative.

According to Professor Gross, the etiological factors in this pathological condition are masturbation, sexual excesses, and gonorrhea.

The effects produced by these etiological factors are frequently maintained by the existence of one or more strictures. A rational system of therapeutics is based on a correct understanding of pathology. A correct understanding of the pathology of any function implies a correct knowledge of its

physiology. We shall therefore state briefly the essential facts of the physiology of erection.

190. Physiology of Erection.—Eckhard* demonstrated that rigidity in erection was due to an increased supply of blood to the penis. Lovén† further demonstrated that increased supply of blood was due to an active dilatation of the arterioles of the cavernous and spongy bodies, and not by a constriction of the veins producing passive congestion as had been formerly taught. Venous congestion has an undoubted effect in maintaining erection, but it is not the active agent. The teaching of Lovén is important to remember, particularly at the present time when litigation of the dorsal vein of the penis is an operation somewhat in vogue in the treatment of impotence.

The nerves concerned in the act of erection arise by two roots at the sacral plexus, from the second, third, and fourth sacral nerves. They are known as the erigent nerves, and, when stimulated by an electric current, erection and ejaculation are produced, while their division renders erection and emission impossible.

Eckhard, in experimenting on dogs, produced erection by stimulating the lumbar cord, the cervical cord, and also the pons and crura cerebri. From these experiments he concluded that the fibers of the erigent nerves, the electric stimulation of which caused erection, came from the cerebrum and passed down through the crura and pons to the cord. Goltz‡ proved that after dividing the cord above the lumbar region, irritation of the glans penis produced a full erection. He therefore demonstrated the existence of an independent reflex center in the lumbar region of the cord.

The erigent nerves not only contain fibers, the stimulation of which produce erection, but also fibers coming from the brain, which convey inhibitory impulses preventing erection. The inhibiting action of the brain on the reflex center in the lumbar cord was also demonstrated by Goltz.

*Beiträge zur Anat. und Phys., Bd. III, page 125 and Bd. VII, page 67.
†Arbeiten aus der Phys., Anstalt zur Leipzig, 1866, page i.
‡Pflüger's Archive, Bd. VIII, page 460.

To recapitulate, there are three centers governing erection: (1) Nerve-centers in cerebrum (psychical); (2) an independent reflex center in the lumbar division of the cord; (3) the peripheral nerves

It is important to remember that the mechanism of erection is not merely a retention of venous blood, but an afflux of arterial blood into the elastic erectile tissues of the penis. This mechanism, however, cannot take place by itself and is induced and governed by the power of the nervous system as explained above. This knowledge is of the greatest importance in making a correct diagnosis and in instituting and carrying out an intelligent plan of treatment. We have devoted these few pages to the pathology of impotence and the physiology of erection, in order to describe the treatment of impotence in a rational manner.

ELECTRICAL TREATMENT

191. There is no electric modality that has not been tried in the treatment of impotence, and, according to Larat,* all modalities have given some good results among many failures. This author believes in the psychical action of electric currents in the treatment of impotence Accordingly, he tries one modality after the other and perseveres with the one that seems to do the most good. In the treatment of 20 cases, which he does not classify, Larat obtained 30 per cent. of cures. Lewandowski† dismisses the subject of impotence in less than one page, and recommends the negative pole of the direct current intra-urethral and also externally to the perineum, scrotum, and penis, the positive pole being placed on the lumbosacral region. In symptomatic impotence, he claims very excellent results for this line of treatment.

192. Erb‡ states that the majority of cases of impotence require direct electrical treatment of the genitals, and this may constitute the main feature of the treatment if the sexual dis-

*Larat, "Traite Practique D'Electricité Médicale."
†Lewandowski, "Elektrodiagnostik und Elektrotherapie."
‡Erb, "Handbook of Electrotherapeutics."

order is the sole or predominant symptom. Erb recommends the galvanic current as follows:

"The anode (large electrode) is placed on the lumbar cord, and the cathode (medium electrode), stabile and labile, along the seminal canal from the inguinal ring downward, for 1 or 2 minutes on each side; the current should be tolerably strong, so that a distinct burning sensation is produced in the integument. This is followed by a vigorous labile application of the cathode (1 minute) to the upper and lower surfaces of the penis as far as the glans; finally the cathode may be applied labile and stabile upon the perineum as far forward as the root of the penis (1 to 2 minutes); a few interruptions or changes of polarity may be made, in order to secure more active stimulation. If the penis, especially the glans, is anesthetic, the cathode may be applied in this position for a longer period. If the testicles are atrophic, flaccid, and the scrotum cool, the current may be passed directly through them."

In severe and obstinate cases, Erb applies the direct current to the lumbar divisions of the cord. The treatment must be continued for a long time, at least 6 to 8 weeks (daily sittings), and often much longer. These electrical applications may be combined profitably with other measures of treatment. The treatment was generally carried out by Erb with very satisfactory results in cases of impotence of the atonic type.

These cases were characterized by the so-called "irritable weakness" of the sexual function, with feeble erections and premature ejaculations, abnormally frequent nocturnal pollutions, leading, finally, to daily pollutions and spermatorrhea. These conditions were accompanied by symptoms of neurasthenia and particularly by marked hypochondriac depression.

193. Arthuis* used static methods in the treatment of impotence. His treatment consisted in the application of frictions and sparks to the lumbar spine and to the perineum. For the neurasthenic symptoms of impotence, he used general static methods with localization to head and upper cervical spine. In organic impotence due to congenital or acquired malformation

*Arthuis, "Électricité Statique."

or injuries, electric currents are of no service. Where the impotence is due to disease, electric currents are valuable agents in restoring tone to the genital system and in correcting defective states of local nutrition. The thickening and induration that remains after gonorrheal epididymitis may be decidedly benefited by the judicious local application of negative galvanism.

194. There occur cases of impotence in young men who are well developed and strong with the exception of the penis and testicles. They have never had any decided sexual inclination; their penis and testicles are somewhat shrunken and anesthetic. These patients have a tendency to hypochondria. When erections do occur they are incomplete and are not of sufficient duration to permit coition. The electrocutaneous sensibility of the penis and particularly the glans is considerably diminished. In these cases the faradic brush applied to the testicles, to the upper and lower surfaces of the penis, and also to the glans penis, gives excellent results.* The application of the faradic brush causes the skin to become red and warm, the penis appears less shrunken, and occasionally during the application an erection takes place. Usually, however, an erection occurs some hours after the application. About twenty or thirty applications are required to effect a cure. In the congenitally abnormally small penis and testicle, the results of the applications of the faradic brush are surprising. In the majority of cases, the evidence of increased development is manifest after 2 or 3 weeks' treatment. Atonic and psychical impotence are frequently difficult to differentiate. In this regard the following words of Sir J. Paget will be found useful: "If a man has sexual organs, including the prostate, not manifestly diseased or wasted, and has erections and occasional nocturnal emissions and any sexual desire, you may be sure that he is not impotent unless he has very clear facts to prove that he is. The statements that hypochondriacs make to show that they are or are becoming impotent are usually evidence that they are not."

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*Erdmann, "Die Anwendung der Electricität in der Praktischen Medicin."

195. Of 153 cases of impotence studied by Gross, 127 were of the atonic variety, characterized by feeble erection, premature ejaculation, and due to or maintained by hyperesthesia and chronic inflammation of the prostatic urethra. The treatment of this variety of atonic impotence is of the greatest importance, owing to its frequency. Gross did valuable work in pointing out the pathology of this condition and the treatment inaugurated by him is, on the whole, good. His treatment consisted in the regular passage of steel bougies, with the internal administration of bromids, gelsemium, etc. The application of the wave-current, as recommended by Doctor Snow, or the sinusoidal current with one electrode in the rectum and pressed against the prostate, are rapid and efficient means of overcoming the hyperesthesia and inflammation of the prostatic urethra, and at the same time they tone up the exhausted genital center in the lumbar division of the cord particularly when the external electrode is placed over the lumbar division of the cord. Masturbation is the most frequent cause of atonic impotence, and, as masturbators are inclined to regard impotence as the heritage of their vice, the general tonic effects of the wave-current and sinusoidal current are rigorously indicated. The local application of the sinusoidal current to the prostatic urethra per rectum may be advantageously alternated with the sinusoidal bath, or the bath with four cells. The victims of atonic impotence frequently complain of a long list of symptoms, but the majority of the symptoms will be rationally treated by the proper application of one or more of the electric currents now used in medicine and surgery.

196. When the hyperesthesia of the prostatic urethra is reduced by the application of the wave-current or sinusoidal current per rectum, or by the regular passage of steel bougies, negative galvanism (3 to 4 milliamperes) may be directly applied per urethra to tone the structures of the prostatic urethra and ejaculatory ducts. In many cases, the entire spinal cord and particularly the lumbar division, will require applications of the galvanic current in the following manner: An electrode (5 in. $\times$ 7 in.) is placed on the cervicodorsal

region and another electrode (8 in. × 12 in.) is placed on the lumbar region. The cervicodorsal electrode is made positive. From 30 to 40 milliamperes are passed for 10 minutes three times weekly.

The causes underlying and maintaining atonic impotence must be located and removed, or all plans of treatment will be of no avail. A tight or redundant prepuce should receive surgical attention; strictures, so frequently encountered in atonic impotence, should be treated according to directions given in the treatment of strictures; and any source of irritation to the glans penis, as accumulation of secretion or herpes, should receive attention.

Therapeutics of Static Electricity.

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CONSTITUTIONAL DISEASES.

DIABETES MELLITUS.

1. Pathology.—The physiological chemistry of sugar formation in the human economy is inseparably associated with the pathology of **diabetes.** Sugar is indispensable to the normal functions of the human organism. It is stored in the anatomic elements, where it undergoes transformations. It has its part in the reparation of tissue, and through the processes of combustion it is a source of heat and force. One of the most beautiful discoveries of Claude Bernard is that of the *glycogenic function of the liver*. By the glycogenic function of the liver is meant the capacity of the hepatic cells to form from various materials an amyloid substance known as *glycogen*. From what materials and how is glycogen formed in the liver? Glucose, or grape-sugar, is the highest expression of intestinal digestion of the carbohydrates taken into the body in an ordinary mixed diet. The sugars and starches taken into the body are converted into glucose by the saliva and the pancreatic and intestinal juices. This glucose is taken up by the portal vein and carried to the liver, but in this form it can neither remain in the liver nor pass through it into the general circulation. The glucose derived from the intestinal tract through the portal vein is converted into glycogen by the hepatic cells. The hepatic cells also form glycogen from nitrogenous articles of food, in the metabolism of which glycogen and urea are formed, the urea being transported to the kidneys and the glycogen being stored in the liver. Moreover, it is not only

from the carbohydrates and nitrogenous substances recently taken that the liver forms glycogen, but also from reserve material stored up in the tissues and organs, as is proved by the fact that the liver of an animal deprived of all food continues to make glycogen. The glycogen stored in the liver comes then from three sources; namely, (1) from the glucose, or grape-sugar, derived from the intestinal tract; (2) from the metabolism of nitrogenous food; (3) from the reserve material in the tissues and organs.

2. **Glycogenic Function of the Liver.**—The glycogenic function of the liver is expressed in its capacity to convert materials from three different sources into glycogen. The glycogen thus formed and stored in the liver is again transformed by a ferment, probably formed in the liver, into glucose, and passes through the hepatic veins into the general circulation. Man in perfect health utilizes and burns all the glucose that passes into his hepatic veins, and the products of this combustion—water and carbon dioxid—are eliminated by the skin, kidneys, and lungs, while heat and force are supplied for the functions of the body. In the subject of diabetes, this destruction does not take place, and a portion, more or less considerable, of the glucose turned into the hepatic veins traverses the system unaltered, and in this state is eliminated from the circulation by the kidneys.

3. **Glucose.**—Glucose enters the circulation in what is practically a fixed proportion (about 1 to 1,000). Some of this glucose in the blood is again converted into glycogen in the muscles, and is stored in them for use in the production of heat and force. According to Lepine, by far the largest portion of the grape-sugar in the blood is destroyed by a glycolitic ferment formed in the pancreas. When the whole or at least 90 per cent. of the pancreas is removed, or when it is so diseased that this ferment is not produced, glucose is not destroyed, but accumulates in the blood, and is excreted by the kidneys. This proportion of grape-sugar, normally existing in the blood, is maintained by the equilibrium established between the amount of glycogen formed in the liver and the amount of

glucose consumed in the blood. When this equilibrium is destroyed, diabetes is established.

4. Glycogen Transformation.—In the formation of sugar within the body, there are two distinct phenomena; namely, the creation of glycogen by the hepatic cells, and the chemical phenomenon that transforms glycogen into dextrin and then into glucose. During life, these two phenomena—the formation of glycogen by the hepatic cells, and the transformation of glycogen into glucose by the action of a ferment, probably formed in the liver—go on at the same time; but after death, glycogen formation, or the vital phenomenon, is arrested, whereas the transformation into glucose, or the chemical phenomenon, continues. This explains why, after washing the liver of an animal several times, traces of glucose still remain.

5. Cause of Diabetes.—Claude Bernard teaches that diabetes is due to an exaggerated production of glycogen. He does not, however, attribute this increased production to a simple increase of the functional activity of the liver. He admits a general disturbance of the nutrition, with a special effect on the liver. At the present time the tendency is to attribute diabetes to a general disorder of nutritive activity, without giving to the liver the importance assigned it by Claude Bernard. This perversion of nutrition is interpreted in two ways. Lecorché and Jaccoud admit an increased metabolism of nitrogenous substances—the decomposition of the nitrogenous portion of food into glycogen and urea. Bouchard teaches that the nutritive trouble is primarily and essentially due to a lack, or insufficiency, of the consumption of sugar in the anatomic elements of the body. He classifies diabetes among those morbid states characterized by retardation of nutrition. There is no theory yet given applicable to all the clinical phenomena and pathological data of diabetes.

6. Diagnosis.—The beginning of diabetes is habitually insidious, many persons passing from ½ to 1 ounce of sugar daily without the least suspicion that they have diabetes. It is important to recognize the disease in its incipienoy and

before the supervention of any marked physical dechéance, in order that proper treatment—dietetic, hygienic, medical, and electrical—may be instituted. It is for this reason that diagnosis is here considered. The diagnosis is easy, and mistake is impossible when all the major symptoms—polydipsia, polyphagia, and polyuria—are present. To recognize all the minor accidents and refer them to their proper source will require careful investigation.

7. The saliva of a diabetic patient is acid, due to the presence of lactic acid coming from the fermentation of sugar. The gums become soft and bleed easily, and the teeth, due to a gingivitis, frequently fall. The eyesight becomes less acute, due to a weakening of the power of accommodation. The failure of vision is rapid, making it necessary to change glasses every few months. General pruritus without any cutaneous eruption should always cause the physician to suspect diabetes and examine the urine. This pruritus is often very tenacious and trying for the patient. Eczema of different portions of the body, particularly vulvar eczema, is frequently associated with diabetes. Vulvar eczema is the cause of much suffering, and does not yield to the ordinary treatment of eczema. The cause of the eczema must be looked for and treated.

8. Symptoms.—Symptoms referable to the nervous system are muscular weakness, fatigue, and inaptitude for work, mental or physical. There may be pains in the muscles and nerves that are easily mistaken for rheumatism. Sexual impotence is frequently attributed to old age or excess when in reality it is produced by diabetes. Urethritis, balanitis, and phimosis are sometimes caused by fermentation of the sugar in the urine. The prolonged contact of a few drops of urine altered by sugar fermentation explains these disorders. The urethritis is localized to the anterior portion of the urethra, and is accompanied by a very lively pruritus. When phimosis complicates the urethritis or balanitis, it is of the utmost importance that the true nature of the inflammatory trouble be recognized. Any operative procedure may be extremely grave, whereas proper treatment usually proves rapidly

efficacious Those are the principal minor symptoms of diabetes by which the physician may recognize the disease at a time when the patient has no suspicion whatever of the chronic disease with which he is attacked.

TREATMENT.

9. Diet and Exercise.—The diet and its regulation dominate the therapeutics of diabetes. It is not meant by this that the diet must be rigid and severe, but that it should be regulated to the best interests of the patient. If a patient is enjoying fair health with a small quantity of sugar in the urine, it is not wise to eliminate this small quantity of sugar from the urine by severe dieting, at the expense of his health and comfort. Starches and sugars are to be avoided, and, if wine is used, it should contain no sugar. As the tissues of the body are more or less dehydrated and the patient's thirst often imperative, he should be advised to drink water in large quantities, to satisfy his thirst; it will also favor the elimination of sugar from the body.

The value of exercise in diabetes is too much ignored. As sugar is stored in the muscle-cells, the necessity of exercise to consume the sugar is apparent. In the very nature of diabetes there is a marked tendency to lassitude and a repugnance to exertion of any kind. These should be discouraged and the patient taught the necessity of daily walks, or what may be well called restful exercise of some sort. Many a diabetic owes his comparative restoration to health to the selection of an occupation that required moderate physical labor. The exercise must, however, be kept within the limits of the physical capacity of the patient, as it has been frequently noted that diabetic coma follows fatigue or excess of some kind.

10. Drugs Used.—Among the drugs used, opium or its alkaloid, codein, is most generally assigned the first place. Many complete cures have been reported from the use of codein. Next in importance comes arsenic, which may be given in the form of Fowler's solution or the soda-salt. Within

recent years, French authors have reported excellent results from the use of antipyrin administered in 10- or 15-grain doses three times daily. It is most likely that there are many different factors in the pathogeny of diabetes mellitus, and that these factors acting on the same neurovisceral structures produce the clinical syndrome comprised in diabetes. This would explain the good results reported from the administration of so many different drugs whose therapeutic properties are known to be essentially different.

11. Use of Static Electricity.—Diabetes does not tend to spontaneous recovery. Placebos and expectant treatment are out of place. Full recovery is rare if the disease is established before the age of twenty-five. Nearly all mild cases can be improved by skilled treatment, but will get worse if neglected. The age of commencement, the lapse of time before treatment, and the kind of treatment given affect the prognosis. The older the patient when first attacked, and the earlier the commencement of treatment, the better the prognosis. It is safe to say that the addition of static electricity to the best dietetic, hygienic, and medicinal measures can be made to revolutionize the average comfort of the patient and prospects of duration of life.

With the aid of static electricity, the importance of a rigid adherence to an antidiabetic diet is reduced to a minimum. Even the question of a specific drug becomes of secondary interest in an ordinary case. The objects to be sought in directing static applications are to regulate the general functions, increase tissue resistance, and relieve symptoms. Each patient will therefore require individual consideration, and, in the early stages, benefit will, of course, be much more marked than when the end approaches. Methods to bear in mind are the general nutritional methods of positive electrification and potential alternation, together with indicated localizations of the breeze, spray, frictions, and sparks. Impressions on the cerebral and spinal centers should be made at each séance in the manner best suited to the case. Sedation will be effected by the positive spray, and counter-irritation by frictions.

DIABETES INSIPIDUS.

12. Pathology.—In the urinary pathology of diabetes mellitus, the increased quantity of urea and of the phosphates and chlorids excreted in the urine daily adds considerably to the drain already made on the system by the loss of sugar. In conditions of health, the quantity of urea daily excreted amounts to about 25 grams. In diabetes mellitus the total daily excretion of urea frequently exceeds 40 grams, and may be 60 grams or more. In **diabetes insipidus,** the characteristic symptom of which is polyuria and its necessary consequence, polydipsia, the solid urinary constituents, notwithstanding the marked increase of water secreted, undergo no change. A thorough examination of the urine in all forms of diabetes is absolutely necessary to a correct diagnosis and to a rational treatment. In diabetes mellitus, the chief feature of the urine is the sugar that it contains, though the amount of urea, and of the phosphates and chlorids, may be and usually is increased. Another form of diabetes is characterized clinically by the absence of sugar, a marked increase in the excretion of urea, and the general symptoms, polyuria, polydipsia, and polyphagia, closely resembling diabetes mellitus.

13. To establish this form of diabetes it requires more than an excess of urea. It is a general disease, having two distinguishing features; namely, an exaggerated excretion of urea and the general symptoms usually present in diabetes mellitus. The amount of urea excreted is very high—sometimes 100 grams. Grave cases of this disease (azoturia) present the symptoms and complications of diabetes mellitus, and usually run the same course. A careful examination of the urine is here particularly important, because the quantity secreted in 24 hours may be normal, with a very large amount of urea and grave general symptoms. The amount of phosphates in the urine is sometimes so great that it dominates every other element in the urinary analysis, in which case the diabetes is known as *phosphatic diabetes*, or *phosphaturia*.

In chronic polyuria, without any excess in the daily amount

of the solid constituents of the urine, and without any substances foreign to the normal urine, such as sugar or albumen, the etiology and pathogeny are as undetermined as in diabetes mellitus.

14. Diabetes insipidus may begin suddenly and last indefinitely without compromising the health. It is not accompanied with the emaciation, malnutrition, and grave nervous troubles so characteristic of diabetes mellitus. According to Senator, most cases that have been established for more than a year may be regarded as "troublesome, rather than dangerous." The urine does not contain an excess of solid constituents; there is no waste, and the disease may last for years without symptoms other than those of dyspepsia and obstinate constipation. In some cases the disease is hereditary, and in a large number of reported cases it seems to have a nervous origin. Injuries to the head and different portions of the body, or diseases of the brain, the medulla, and the fourth ventrical, are cited as causes of diabetes insipidus.

TREATMENT.

15. A résumé of the ordinary therapeutics will be useful to the student of static electricity. "Opium, gallic acid, ergot, and valerian are the chief direct drugs." Tonics and nerve-foods are added when debility sets in. The best hygienic conditions are advised. The actions of all these may be aided or superseded by the potential efficacy of static currents; but any associated conditions, such, for instance, as syphilis, should receive due medical attention. It has been observed, however, that "the symptoms of diabetes insipidus are almost always influenced and sometimes even cut short by intercurrent disease, especially of a febrile character, or even by a profound physical impression, as long-continued suppuration after a blister." This fact has suggested a large blister at the nape of the neck or on the epigastrium, according as the symptoms advise impressing the digestive or the nervous system.

16. The chief desired impressions of either "intercurrent disease" or "blister" and the tonic actions of "sea-air, exercise,

etc.," may be secured by static electricity, without any of the sacrifices entailed by disease, blisters, prolonged suppuration, or change of residence. The general tonic measures of positive electrification or potential alternation, together with the symptomatic local uses of the breeze, spray, frictions, and sparks, have been advocated as fulfilling the indications of treatment. Impressions on the region of the solar plexus or spinal centers may be efficiently made by rubefacient frictions and sparks, without a moment's discomfort to the patient afterwards, such as would be caused by any form of blister employed. A careful review of the physiological actions of static electricity will prove of profit to the profession, and will disclose the fact that its dose-regulation is not empirical, but admits of scientific accuracy (see *Technique and Physiology of Static and Other High-Frequency Currents*).

GOUT.

17. Etiology.—Gout is an acute and chronic constitutional affection caused by the sudden and somewhat copious deposition of sodium biurate in the tissues and organs of the body. If the deposition of sodium biurate takes place in the structures of the joints, the affection is called *articular gout;* when the deposit is in other tissues or organs it is known as *abarticular gout.* These two varieties are also known as *regular* and *irregular* gout, arthritis being the most marked expression of gout. In autopsies made on individuals that succumbed to interstitial nephritis, and that during life never suffered from any form of gout, about 75 per cent. were found to have uratic deposits in the structure of the joints. From this it is seen that, in order to produce the clinical tableau of gout, it is necessary that the deposit be both sudden and copious. A slow and gradual deposit may take place without producing any manifestations of gout whatever An analogy to this is found in renal pathology, and in many other of the pathological processes of the human body Sudden and complete suppression of renal activity rapidly establishes uremia. The kidneys may be impaired in their function for years, causing a gradual retention of small amounts of those elements that produce

symptoms of uremia and yet no clinical evidences of disease may appear.

18. Pathology.—Uratic deposits are almost exclusively found in structures belonging to the connective-tissue type. They are found in fibrous tissue in cartilages and also in tendons and ligaments. Urates does not occur in the substance of the liver, spleen, lungs, muscles, or in the digestive tract.

In studying the pathology of gout, Luff arrived at the following conclusions:

1. Uric acid is not normally present in the blood of man and other mammals, but is in the blood of birds.
2. Uric acid is normally produced only in the kidneys.
3. Uric acid is normally formed from urea, probably by conjugation of that substance with glycocine in the kidneys.
4. Uric acid is present in the blood in gout as the soluble sodium quadriurate. In its soluble form it is not a toxic agent. It deposits from the blood as sodium biurate, which acts mechanically and physically as a foreign body in the tissues or organs in which it is deposited.
5. In gout the presence of uric acid in the blood is due to the deficient excretion of the acid by the kidneys and to the subsequent absorption of the non-excreted portion into the blood from those organs.
6. Gout is probably always preceded by some affection of the kidneys, functional or organic, that interferes with the proper excretion of uric acid. The probable seat of the kidney affection giving rise to gout is in the epithelium of the convoluted tubes.
7. In certain blood-diseases and disorders accompanied by leucocytosis, uric acid is formed within the system from nuclein. In such circumstances, it passes at once into the blood and is rapidly eliminated by the kidneys.

19. Primary Factors in Gout.—From these statements on the pathology of gout it is evident that the primary pathological factor in the production of an attack of gout, articular or abarticular, must be looked for in a deficient capacity on the

part of the kidneys to eliminate the uric acid normally formed within their structure. It will be further observed that uric acid is not considered as an antecedent of urea, but that it is formed in the kidneys by the conjugation of urea with glycocine, a product of hepatic metabolism. The view that uric acid is oxidized and destroyed by oxygenated blood is not supported by any experimental proof. There is, however, experimental proof that uric acid is produced from nuclein by a process of oxidation. In leucocythemia and in severe anemia and other disorders accompanied by leucocytosis, the quantity of uric acid in the blood in the form of the soluble quadriurate is about six times greater than that found in the blood during an acute attack of gout, and yet there are no symptoms of gout manifest in leucocythemia or anemia. The cause of this absence of the symptoms of gout in disorders accompanied by leucocytosis is to be found in healthy kidneys that excrete the quadriurate of sodium before the comparatively insoluble biurate is formed or deposited in the tissues or organs of the body. It is thus seen that healthy kidneys are capable of excreting six times the quantity of quadriurate of sodium found in the blood in an attack of gout without any damage to any tissue or organ of the body. Normally, uric acid is formed in the kidneys, and if the kidneys are healthy, the uric acid is all eliminated in the form of sodium quadriurate. In certain diseases characterized by leucocytosis, uric acid is formed within the system from nuclein; but, if the kidneys are intact, it is eliminated as sodium quadriurate before any deposit can take place in the connective-tissue structure of the body.

20. As a guide to the diet and drug treatment of gout, the following conclusions have been arrived at:

1. The alkalinity of the blood is apparently not appreciably diminished during a gouty attack.
2. The solubility of uric acid in the blood is not affected by a diminished alkalinity of the blood produced by the addition of organic acids.
3. The deposition of sodium biurate is not accelerated by a diminution of the alkalinity of the blood.

4. An increased alkalinity of the blood does not increase the solubility of deposits of sodium biurate.

5. The gout-inducing properties of certain wines are not due to their acidity. They probably owe their gout-inducing action to the effect that they exercise on the metabolism of the liver.

6. The solubility of sodium biurate is markedly increased by the presence of the mineral constituents of most vegetables.

7. The solubility of sodium biurate is diminished by the presence of the mineral constituents of meat.

8. The mineral constituents of certain vegetables delay the conversion of sodium quadriurate into biurate.

9. The vegetables most useful to gouty subjects are spinach, Brussels sprouts, French beans, winter cabbage, Savoy cabbage, turnip-tops, turnips, and celery.

10. The administration of the ordinary alkalis, and of the lithium salts, of piperazine and of lysidine, with the object of removing gouty deposits, appear to be useless.

11. No general acidity of the system is associated with gout.

12. No relationship exists between the acidity of the urine and the alkalinity of the blood.

13. The administration of salicylates with the object of removing gout deposits appears to be useless, and their employment in the treatment of gout is contraindicated.—*Luff.*

21. During a course of salicylate of sodium in the treatment of gout, the daily amount of uric acid found in the urine is increased. This increase, however, is not due to the solvent action of the salicylate on the uratic deposits in the joint structures or other tissues of the body, but to an increased production of glycocine brought to the kidneys from the liver and a consequent increased formation of uric acid. For this reason, salicylate should not be administered in an attack of gout. The only drug remedy of any value in the treatment of acute gout is colchicum. Colchicum relieves pain by depressing cardiovascular action, and it diminishes the formation of uric acid by its action on hepatic metabolism, which lessens the amount of glycocine brought to the kidneys. Colchicum is a

direct cholagogue, and to be effective must be administered in large doses.

22. Although gout, in the great majority of cases, occurs in middle life or in advanced years, yet it may occur earlier, particularly if a marked hereditary tendency exists. Hereditary predisposition is certainly the most important factor in the development of gout. Just what is comprised in heredity is not yet determined. It has been demonstrated within recent years that the tendency to granular kidney is hereditary, and it is very probable that the tendency to functional or organic disease of the kidneys is the hereditary factor of gout. Virchow has often observed gout in poorly fed convicts, and in these cases gout could not be attributed to the consumption of excessive quantities of nitrogenous food, insufficient exercise, or alcoholic beverages. An excessive quantity of uric acid in the blood in the form of the quadriurate of sodium will not produce gout so long as the kidneys remain normal.

23. Diathesis.—Before describing the drug and static electrical treatments of gout, the gouty diathesis should be considered. An acute paroxysm of gout is but an episode in the life of a gouty individual. From the ages of ten to twelve the individual that has inherited a gouty disposition will be attacked from time to time by some manifestation of the gouty diathesis. About the age of puberty he will be likely to suffer from hemorrhoids, epistaxis, megrim, or eczema. Later on he may suffer from acid indigestion and chronic constipation, with uratic sediments in urine. The position of asthma in the gouty diathesis has long been recognized. There may also be attacks of hepatic colic, renal colic, carbuncles, and a marked tendency to obesity. It has been frequently observed that those that suffer from uric-acid gravel in early life are very likely to have paroxysms of gout in mature age.

TREATMENT.

24. Dietetic and Medicinal Treatment.—The acute paroxysm, chronic gout, and the early manifestation of the gouty diathesis will require special consideration. In acute

long positive sparks to the general muscular surface of the body, including the spine and the abdomen, with séances *t. i. d.* at intervals of 4 hours, until the attack is aborted. Then proceed as for chronic gout.

2. The chronic state of gout demands measures adapted to the condition and to symptomatic indications—frequency of séances depending on the relief afforded, which in turn depends on the nearness of an acute attack and the severity of the symptoms. Pains of small joints may be relieved by some degree of spray between sedative and counter-irritant. Also by a sedative rapidly interrupted Leyden jar bath, using the smallest jars with a small spark-gap. Muscular pains are relieved by sparks. Headaches, mental distress, and disturbance of the faculties indicate a sedative-tonic head-breeze. The combination of potential alternation and muscle-contracting sparks combats the uric-acid state, promotes combustion, aids elimination, warms cold extremities, regulates circulation and nervous energy, and supplies an efficient substitute for exercise and various remedies.

3. The effects of gout on the general health, the irritability and debility caused, and the complications developing in later stages, call for methods of application that will occur to the well-instructed student of static electricity at the time of treatment. To describe them here, however, would be to review a large part of the whole subject of static electricity in general medicine.

With the object of aborting acute attacks, preventing relapses, improving the general state, and substituting a life of comparative comfort and activity for pain and incapacity for work, the frequency of treatment should be governed by the state of the patient and the results obtained, and it should be kept up until a period of immunity is established, and resumed again when indications arise. Dietetic and medicinal treatment will be governed by the physician's judgment.

MUSCULAR RHEUMATISM.

27. Pain is the most prominent symptom of **muscular rheumatism,** and any pain in a muscle is popularly believed to be rheumatic. An attack of acute articular rheumatism is

usually preceded by a feeling of chilliness, malaise, and pain or soreness in the muscles. Muscular rheumatism has no mortality. Our knowledge of its pathological anatomy is almost *nil.* When there is evidence of active inflammatory changes in the muscles, the condition is described as myositis. To make a diagnosis of muscular rheumatism, the history of the patient should be carefully investigated, and if there is a hereditary history of rheumatism, and, for still stronger reason, if the patient has previously suffered from acute articular rheumatism, an attack of muscular pain may be inferred to be rheumatic. The distinguishing feature of a rheumatic muscular pain is that it is increased when the muscle is used or put on the stretch. Among the abarticular manifestations of rheumatism, the muscular variety, on account of its prevalence in the form of lumbago, torticollis, and pleurodynia, is worthy of close attention.

28. It is not always easy to trace the limitations of rheumatism, even when it expresses itself in its frankest form, with a number of the usual joints involved. In the abarticular variety, with the joints intact and the rheumatic poison manifesting itself in the muscles and nerves, to establish a causative diagnosis is extremely difficult. In muscular rheumatism there are no articular localizations to guide the physician in his diagnosis. A muscular pain is not necessarily rheumatic because it is produced by exposure and cold. What then are the distinguishing features of muscular rheumatism?

1. It localizes itself chiefly in the large muscles of the shoulder, arms, back, and thigh.
2. The pain of muscular rheumatism is made worse by movements, and considerably worse by muscular tension.
3. The pain is generally diffused over the muscles and fascia affected.
4. In the articular variety, the pain flies from joint to joint; this does not occur in the muscular form, which is limited to the affected muscles.
5. There are no localized spots of tenderness; one part of the muscles is about as tender as another.

6. Rest affords relief to the affected muscles.

7. The history of the patient, hereditary and personal, will give important aid.

The pathological conditions with which muscular rheumatism is most frequently confounded are myositis, neuritis, and neuralgia, and all three may be caused by the rheumatic poison. Overwork, fatigue, cold, and exposure are the usual exciting causes, and these, taken with the history, hereditary and personal, of the patient, will be likely to establish a correct diagnosis.

TREATMENT.

29. The drugs used in the acute form are quinin, salicyl compounds, and antipyrin. In the chronic form, there are three therapeutic measures; viz., hydropathy, electricity, and massage. While simple and acute myalgias often yield to both internal remedies and external applications, yet some cases resist or recur with peculiar obstinacy. Counter-irritation and massage will be found among the recommendations of standard textbooks on therapeutics. These actions are efficiently produced (without removing any clothing) by static frictions, by the spray, and by sparks. The patient should be placed in such a posture as to develop the maximum of pain, and then the current applied until the pain ceases. It is so doubtful that any case of true muscular rheumatism will fail to yield to some form of skilled electrical treatment that the apparent failure should lead to question of the diagnosis. Neuritis and neuralgias behave in quite a different manner under static treatment, and this difference often becomes a touchstone to diagnosis. The same is true of its use in many other diseases.

ACUTE RHEUMATISM.

30. Etiology.—The limits of rheumatism are not very clearly determined, and its intimate nature is not yet clearly defined. It is most likely an infectious microbic disease. Acute rheumatism has, without doubt, a marked predilection for the articulations; but it may attack the viscera, heart, and lungs, before the joints. The pathogenic microbe of acute

rheumatism has not yet been found. Its right to be called infectious is based entirely on analogy. Its mode of onset and its course and complications are compared with those of infectious diseases, and found to be so strikingly similar that modern authors do not hesitate to class acute rheumatism among infectious diseases.

31. The special characteristics of acute rheumatic inflammation are:

1. The tendency to its occurrence is hereditary—transmitted from father to son.
2. It is especially liable to occur at a particular age, being rare before fifteen and after fifty.
3. It is apt to attack the same individual again and again.
4. It does not confine itself to one joint, but affects several simultaneously or in succession.
5. It attacks also the membranes of the heart.
6. It very rarely terminates in suppuration.
7. It is not much benefited by measures calculated to relieve simple local inflammatory action, but is speedily subdued by proper constitutional treatment.

32. As the heart is implicated in about 50 per cent. of cases of acute rheumatism, the true cause of the rheumatic inflammation must exist in the system. The endocarditis of scarlatina, erysipelas, or diphtheria is known to be microbic. The endocarditis of acute rheumatism has the same clinical and pathological features, and may therefore be regarded as infectious. The infectious diseases are particularly liable to attack persons between the ages of fifteen and twenty years. Acute rheumatism has the same tendency. Sydenham separated acute rheumatism from gout. Senator separated arthritis, while Zenker separated trichinosis. There still remain five distinct clinical types, in denominating which "rheumatism" or "rheumatic" occupies an essential part.

33. The diseases still described as rheumatic are as follows: (1) Acute rheumatism; (2) chronic articular rheumatism; (3) arthritis deformans; (4) muscular rheumatism; (5) pseudo-rheumatism, or the arthritic manifestations of

known infectious diseases, such as scarlatina, diphtheria, erysipelas, and gonorrhea. There is a marked tendency at the present time to confine the word *rheumatism* to the acute variety characterized by a sudden onset with chill or chilliness and fever like any other infection, with inflammation of a number of joints, profuse sweats, and a disposition to attack internal viscera. This view then makes rheumatism a systemic disorder; and while arthritis is an important clinical manifestation, it must be remembered that the systemic condition exists without any articular trouble, the rheumatism exhibiting itself in such phenomena as chorea, fibrous nodules, erythema, angina, endocarditis, and pericarditis.

34. Pathology.—In mild forms of rheumatism the attack lasts a few weeks. A case marked by high fever and intensity of inflammatory symptoms may last 5 or 6 weeks; and after the pain, fever, and swelling disappear, the patient is often extremely weak and profoundly anemic. Relapses are not uncommon, and may take place in spite of the best hygienic precautions. A fact to be borne in mind is that patients convalescing from rheumatism remain still liable to visceral complications. Inflammation of the endocardium is undoubtedly the most serious complication of acute rheumatism. In acute rheumatism the fibrin of the blood is usually increased. The synovial membrane is swollen and hyperemic, the synovial fluid is increased in quantity, and in long-standing cases the cartilages may be eroded.

35. Rheumatism is essentially a disease of the fibrous and serous structures of the body. Its poison (parasitic, miasmatic) finds its nidus in these tissues and is propagated there. Two factors are therefore necessary for the production of acute rheumatism: a poison introduced from without, and that condition of the fibrous and serous tissues which makes them a nidus for the rheumatism-poison. This special fitness of the fibrous and serous textures of the body for the propagation of the rheumatism-poison, and the introduction of the rheumatism-poison into the body, explain very well the origin and clinical course of acute rheumatism.

36. All the phenomena accompanying an average attack of acute rheumatism may be tabulated as follows:

1. Local inflammatory lesions accompanied by general febrile disturbances.
2. These inflammatory lesions are limited to the motor apparatus and the left side of the heart.
3. The disease usually occurs between the ages of fifteen and fifty.
4. There is always present in the blood an excess of fibrin.
5. There is always present in the blood an excess of lactic acid.
6. The inflammatory lesions locate in one joint after another, and may during the course of the disease attack the same joint more than once.
7. Profuse acid sweats are an essential characteristic of every acute rheumatic attack.

37. The excess of lactic acid in the blood is due to the increased metamorphosis of non-nitrogenous substances, just as the excess of fibrin is due to the increased metamorphosis of nitrogenous substances. The functional activity of the joints of the body is most severely tested between the ages of fifteen and fifty, and this is given as the cause of rheumatic attacks during those years. The inflammatory lesion becomes inactive in one joint and active in another, because the fibrous structures of the former, as the habitat of the rheumatic poison, is exhausted, while in the latter there is a special fitness for its propagation. The cardiac complications are explained by regarding the structures of the heart as the habitation for the propagation of the rheumatic poison, and in the same manner as the fibrous structures of the joints.

TREATMENT.

38. Inflammatory cases involving large joints do not concern static electricity, for they are outside of its sphere of curative action, although the sedative spray will give temporary relief to pain. The small joints of the hand sometimes have acute swellings, with redness and heat, in chronic rheumatism, and one of the most grateful of applications is the sedative static

spray. It should be repeated until the redness and pain are relieved as much as possible. In subacute and terminal stages of rheumatism of the larger joints, after medical treatment has done its work, the static current becomes valuable to remove lingering pains, restore muscular mobility, and improve the general health. It then surpasses almost all other remedies. In this stage the treatment becomes that of the chronic condition, for which see Art. **41.**

CHRONIC ARTICULAR RHEUMATISM.

39. Chronic articular rheumatism habitually begins as such, and distinguishes itself by remaining a chronic affection. Occasionally it occurs as a sequence of acute or subacute rheumatism. Chronic articular rheumatism is not characterized by the fever, intense pain, or profuse sweating of the acute rheumatic type. The articulations involved are painful on pressure; while motion is difficult, and is accompained by a creaking sound. The joints may be swollen and painful, and motion difficult, and there may be deformity and atrophy of surrounding muscles; but the peculiar grating sound found in arthritis deformans is never present in chronic articular rheumatism. This grating sound is due to the contact of denuded osseous surfaces; and in chronic articular rheumatism the bones are not denuded. It belongs to the last half of life, and is usually a disease of the poorer classes. It confines itself to one or to a few joints and lasts for months, for years, or for life. When compared with acute rheumatism, which is polyarticular, it may be styled *monarticular.* It is characteristic of acute rheumatism to attack joint after joint, whereas chronic articular rheumatism confines itself to one or a few joints.

40. The joint is enlarged simply because the capsules and tendons are thickened. In very chronic cases the cartilages are eroded. The pathological anatomy of chronic articular rheumatism is confined to the soft structures of the joint, and the bones are not involved in the diseased process. The palms of the hands and the soles of the feet are frequently the seat of pain in this form of rheumatism. Chronic articular rheumatism is not accompanied by profuse sweating or cardiac

complications. Prolonged exposure to damp and cold are the most frequent causes of this disease, and the joints so exposed are the ones attacked. Washerwomen have the wrist-joints involved and scrubwomen the knee-joints. The pain of chronic articular rheumatism is dull, aching, and boring. It is distinguished from acute rheumatism by being limited to one or to a few joints, and remaining there. It occurs in the latter part of life, mostly in old people, and is not influenced by drug remedies. It is unattended by cardiac complications, profuse sweating, or high fever. The prognosis as to life is good: but the prognosis as to complete restoration to health is bad. It often affects people whose general health is otherwise good and whose nutrition is near normal. This is in marked contrast to arthritis deformans, so frequently seen in feeble, emaciated, and exhausted women whose nutrition has long been much below par. There is no destructive process going on in the joints invaded by chronic articular rheumatism, while destruction and degeneration are constantly present in the evolution of arthritis deformans. In chronic articular rheumatism the large joints, hip, shoulder, knee, ankle, and wrist are affected. Involvement of the smaller joints would indicate a different disease—gout, arthritis deformans. The periods of immunity from symptoms vary very greatly, and their occurrence is determined by the usual rheumatic influences—dampness, cold, and change of climate.

Chronic articular rheumatism provides a rich harvest for exploitation by irregular practitioners, and for this reason its clinical history and every therapeutic measure of established merit should be thoroughly familiar to the scientific physician.

TREATMENT.

41. There are certain points in which most modern authorities practically concur that should be borne in mind: (1) the prognosis is not favorable to a cure; (2) the disease often resists all remedies and lasts indefinitely; (3) internal remedies are of little service to the joints; (4) the salicylates are useless or of temporary effect; (5) attention to the general health is important; (6) residence in a warm climate is

advantageous; (7) all forms of baths, alkaline, sulfur, Turkish, Russian, mud, and others are uncertain, and are apt to be followed by relapses even when they appear to benefit; (8) local treatment is more important than internal medicine.

It therefore follows that the study of local and nutritional measures constitutes the therapeutics of chronic rheumatism. The nutritional drugs advised are chiefly tonics, iron, and cod-liver oil. To these may be added static electricity, without impairing any virtue they or any others possess. The results would be satisfactory if local effects could be as well secured. The local measures commonly recommended dwell on variations of heat, counter-irritation, and massage. The effects of these may be secured by the static spray, frictions, sparks, and rapidly interrupted Leyden jar currents. Textbooks vary in regard to the value of electricity in these cases. Some speak well of it in vague terms, while others say it is of little benefit. Much depends on the local indications, the current employed, the method and dosage selected, and the duration and frequency of treatment. The galvanic and high-tension induction-currents certainly have their uses in many cases. It is equally certain that the well-taught user of static electricity can do with it much that will benefit the patient. Cases that have not retained the whole benefit of three sittings a week are frequently greatly benefited by daily séances. In obstinate cases that are definitely relieved for 12 hours, but not for an entire day, two treatments daily are recommended until the benefit extends for a greater time, or until the lack of progress is demonstrated. Skilled experience is needed to treat chronic articular rheumatism with gratifying results.

The most important thing to do in beginning the static treatment of a case of chronic rheumatism is to diagnose the indicated therapeutic action that is needed to be set up in the tissues. When this is done, it is merely a question of selecting the form of static application that will produce the action, as taught in *Technique and Physiology of Static and Other High-Frequency Currents.* Our students are especially cautioned against the routine habit of treating all such cases with heavy

sparks. Aim to make a scientific selection of method as between sedation, counter-irritation, stimulation, muscle-contraction, nutritional, alterative, or other needed effects.

GONORRHEAL ARTHRITIS.

42. Gonorrheal arthritis is properly a complication of gonorrheal infection; for, as long as a patient has gonorrhea or any vestige of it in the expression of the slightest gleet, he is liable to the arthritic and other recognized complications of gonorrheal infection. Gonorrhea is an infectious malady, and, like other infectious diseases, it has the capacity to infect the serous membranes of the joints, heart, lungs, brain, and spinal cord. Gonorrheal infection may be followed by inflammation of the joints, the endocardium or pericardium, the meninges of the brain, and the conjunctiva or iris; or it may be followed by alterations of the various fascia and aponeuroses of the body and in large nerve-trunks. There is pain in the feet and in the plantar fascia, particularly in the neighborhood of the os calcis. Gout and gonorrheal rheumatism are known to be the most frequent causes of pain in the heel. The fibrous structure of the plantar arch may be involved, producing flatfoot. The fascia of the lumbar region is frequently the seat of pain. Severe cases of sciatica have been reported due to gonorrheal infection. These various lesions and their symptoms due to gonorrheal infection are collectively described as *gonorrheal rheumatism.*

43. Gonorrheal rheumatism is usually studied in its two chief clinical types; namely, articular when it affects the joints, and abarticular, when it affects the other tissues or organs of the body. In the arthritic type the attack usually comes on during the decline of the local infection or during the existence of gleet. After the complete cure of local infection there is no liability to arthritis, but an individual that has once had gonorrheal arthritis is sure to have joint complications with each new infection. The joints affected are usually the knee, the elbow, and the ankle. The arthritis may begin insidiously, with an effusion into the joint that is usually abundant. In this form the arthritis is not very painful, and the swelling

and inflammation are slow to disappear. There is no tendency to fly from joint to joint, as in acute articular rheumatism. Several articulations may be attacked at the same time, but in this case, also, the inflammation in the course of time limits itself to one joint. There is fever, acute pain, and the local symptom of acute inflammation. The joint affection may last weeks or months. Gonorrheal arthritis is usually defined as a complication of gonorrhea; it is more scientific, however, to define it as one of the local lesions of gonorrheal systemic infection.

44. Arthritis is but one manifestation of systemic infection. The abarticular manifestations are meningitis, pericarditis, endocarditis, neuritis, myositis, iritis, conjunctivitis, and various affections of the fascia. When iritis or conjunctivitis occurs in the course of rheumatism, gonorrhea should always be suspected. An individual may have gonorrhea and rheumatism at the same time, and this must be remembered in making a diagnosis.

Gonorrheal arthritis very rarely terminates in suppuration or tubercular joint affection. A second attack of arthritis is usually more severe, more intractable to treatment, and more likely to produce permanent deformity

The joint and visceral lesions of gonorrheal systemic infection are now usually described as gonorrheal rheumatism or pseudo-rheumatism The other infectious diseases producing symptoms resembling those of acute articular rheumatism are scarlatina, mumps, dysentery, erysipelas, pneumonia, typhoid fever; and, in a number of these diseases, the pathogenic microbe of the acting disease has been found in the effusions in the joints involved.

TREATMENT.

45. The source of infection, whether in the vagina, urethra, or conjunctiva, must be diligently sought for and treated by appropriate remedies. The source of infection should receive the physician's first attention. It is the cause of the systemic trouble, and must be removed. For the treatment of the condition established in the joint, rest is prescribed. While

procuring rest for an inflamed joint due to gonorrhea, the tendency to fibrous-tissue formation and the production of fibrous ankylosis must not be forgotten. The drugs usually prescribed are quinin, the alkalis, and the iodids. The prognosis is usually favorable, complete restitution being the rule. In some cases recovery is slow, and it is necessary to give anesthetics to break up fibrous adhesions. The therapeutic directions for the use of static electricity are the same as previously given under chronic rheumatism. The symptomatic relief and prognosis are improved by the use of this remedy.

ARTHRITIS DEFORMANS.

46. Pathology.—There is no disease in medical nosology that has been described under a greater variety of names than **arthritis deformans.** Clinically, it may be studied in its two chief forms; namely, *polyarticular* and *monarticular*. In both forms there are gnawing pains in the joints affected, limitation of movements, and atrophy of neighboring muscles. In manipulating a joint attacked by either form, the attention is at once arrested by the peculiar grating of the denuded surfaces of the bones.

Arthritis deformans is most common between the ages of forty and fifty. It is much more frequently observed in women than in men, and attacks more particularly the poorer classes. Prolonged damp and cold are said to favor its development, but these two factors are so commonly associated with improper and insufficient food and other depressing conditions that it is not easy to assign them isolated importance in the pathogeny of arthritis deformans.

47. Symptoms.—The chief clinical features of this disease are (1) its tendency to invade joint after joint until the patient is no longer able to move; (2) the deformity that it invariably produces; (3) its symmetrical development, involving the same joints on both sides of the body; (4) the absence of visceral complications—pericarditis, endocarditis. The pathological anatomy is the same, whether the disease assumes the polyarticular or the monarticular form. All the structures

that enter into the formation of the joints are invaded by the diseased process. As a rule there is little, if any, synovial fluid. The synovial membrane is covered with villosities, the underlying connective tissue is sclerosed and thickened, and the cartilage is eroded and destroyed. The surface of the bone is eburnated, while its interior is markedly porous. Deformity is the most characteristic feature of the joint: the muscles surrounding the joint atrophy and waste; the skin has a glossy appearance; luxations occur; and the function of the joints affected is completely destroyed.

48. Monarticular Variety.—The monarticular variety (morbus coxa senilis) is a disease of old age, and has no tendency to spread. It is limited to one or two joints, usually the hip, knee, or shoulder. In its clinical aspect it differs widely from the polyarticular type, in that it has no tendency to progressive invasions or to symmetry, and attacks men more often than women. A fact worth remembering in the etiology of monarticular arthritis is that it often dates from an injury to the joint or to the structures about the joint. The disease with which it is most frequently confounded is sciatica; but the character and distribution of pain will enable a correct diagnosis to be made. The disease is chronic from the beginning, and is characterized by acute acerbations from time to time. It has sometimes followed acute rheumatism or other forms of arthritis.

49. Nodes of Heberden.—Another form of arthritis deformans belonging to this partial type is what is known as the *nodes of Heberden*. Persons having these nodes of Heberden rarely have the large joints affected, and are popularly supposed to have a long life. These nodes have nothing whatever to do with the tophaceous deposits of gout. They are usually situated on the ends and sides of the distal phalanges of the fingers and sometimes of the toes. At times they are tender and painful, particularly when the hands or feet are cold. The formation of these nodes is due to an osteophytic enlargement of the nodules of bone that are normally present in the situations in which they appear, and they are attended by the characteristic rheumatoid changes in the adjacent joint structures. The terminal

joints of the thumbs frequently escape when those of the fingers are the seat of nodular swellings. Patients are usually more disturbed about the deformity accompanying these nodes than they are by the amount of pain or the limitation of movement that they produce. Heberden nodes, from their pathological anatomy and clinical history, must be regarded as a variety of arthritis deformans.

50. Neurotrophic Theory.—Arthritis deformans, whether appearing in the polyarticular or monarticular variety, or simply as the nodes of Heberden, is distinct from either rheumatism or gout. The neurotrophic theory, which was first enunciated by J. K. Mitchell and supported by Charcot's "Studies on Arthropathies," is the best explanation yet given for all the phenomena of arthritis deformans. The chief reasons for considering arthritis deformans as a neurotrophic disease are (1) the resemblance existing between the lesions of arthritis deformans and those of an acknowledged dystrophy of the joints; (2) the peripheral and symmetrical distribution of lesions found in arthritis following concussion of the spine; (3) the etiology of arthritis deformans. The usual causes of arthritis deformans are such as might be expected to give rise to a disorder having for its seat the nervous system. This neurotic theory implies some affection of the spinal cord whereby the bones and joints suffer trophic changes Charcot, Benedict, and Remak favor the neurotrophic theory, on account of the known alterations that occur in the bones and joints in locomotar ataxia.

51. Polyarticular Variety.—This form begins insidiously, progresses gradually and symmetrically, and leaves the joints it attacks more or less deformed. The fingers and hand are usually the most deformed, the index and middle fingers being the seats of election. As a rule, the thumb is not affected. When arthritis deformans attacks the foot, the great toe is generally the greatest sufferer. The deformity is due to contraction of muscles, osteophytic outgrowths, and retraction of fibrous tissue. In cases characterized by the slowness of their evolution, the gradual enlargement of the heads of the bones contribute to the deformity. Arthritis deformans is

distinguished from acute rheumatism by the fact that it attacks the aged and is more frequently met with in women. It remains fixed in the joints and produces permanent deformities. Chronic rheumatism is confined to one or a few joints; it has no symmetry and does not attack the small joints. Gout most frequently affects males and produces deformities by deposits of sodium biurate, while arthritis deformans produces deformities by outgrowth of bones. In gout, the blood contains quadriurate of sodium; in arthritis deformans, this is absent from the blood.

TREATMENT.

52. All that has been written on the dietetic, hygienic, climatic, medicinal, and bath-treatment of this disease may be studied by the physician in standard textbooks. Opinions usually differ about most remedies. Though that excellent authority, Osler, writes, "No benefit can be expected from electricity," he does not state the character of current, method of technique, dosage, or other important details on which his judgment is based, nor the extent of his experience with it. Tyson says he has "seen no permanent benefit from electric baths," but gives no details of technique, current, dosage, etc., and, without these, an opinion of a method so easily misused can hardly be formed. Some authors do not mention electricity at all in connection with this disease. However, physicians that are well taught in the general resources of scientific electrotherapeutics, and possess improved apparatus, can accomplish more with electricity than with other remedies —a statement that is confirmed by clinical observation.

To the end of improving nutrition by cod-liver oil, good food, fresh air, iron, arsenic, iodin, etc., add static electricity in the form of potential alternation, followed by mild sparks, to the general muscular surface. Pain is efficiently relieved by adapting the spray, frictions, or sparks to the character of the pain. Other symptoms must be treated by local applications to meet the indications. Muscle-contracting methods will take the place of massage and exercise, and the local treatment is

the same as for atrophy and paralysis. The nutrition of both wasted muscles and bones of the extremities will be aided by a local bath with the small Leyden jar current rapidly interrupted.

OBESITY.

53. Etiology.—By **obesity** is here meant the accumulation of fat in such quantities as to interfere with the easy play of organs and the normal processes of life. It is a pathological state caused by a generalized hypertrophy of adipose tissue. The accumulation of fat may be either hereditary or acquired. The hereditary disposition to corpulence is established as an undisputed fact. About 50 per cent. of corpulent subjects coming under observation have a hereditary tendency to fat-formation. The acquired form is produced by excess in nutrition and defects in exercise. Either variety may be acute or chronic, but it usually develops slowly. An accumulation of fat is to a certain extent physiological after the meridian of life. "Fair, fat, and forty," is a proverb. A distinction must be made between fat-accumulation and fatty degeneration. Fat-accumulation is the chief feature of obesity, and is curable; fatty degeneration attacks anatomic elements already in a necrobiotic state, and is quickly fatal. Obesity is a disease of all ages. It is most frequently seen in adults, and only occasionally in old age. Women are more subject to obesity than men. In women, the accumulation of fat usually begins at puberty, after marriage, and at the time of the menopause. The marked tendency to fat-accumulation at these epochs in female life emphasizes the influence of the physiology of the sexual organs in the pathology of obesity.

54. The fat-accumulation in obese subjects has the same origin as the fat fixed in the tissues of healthy individuals. The origin of fat is twofold: it comes from the food consumed and also from tissue metabolism. The decomposition products of albumen can be changed into fat. The carbohydrates and alcoholic drinks are more important in the production of excessive fat-formation than the ingestion of fatty articles of food. A fat-cell is capable of considerable metabolism, so that the

same fat does not remain for years in the cells, but is ever decomposed and reformed. Fat is formed in the body by cellular elements from lipogenous material, fats, sugar, starches, and decomposition products of albumen.

55. Pathology.—The pathogeny of obesity is not yet fully elucidated, notwithstanding the large number of histological and physiological examinations that have been made on it. The whole subject is still *sub judice.* The lowered vitality of obese subjects, their tendency to short lives and sudden deaths, and the fact that sterility frequently accompanies obesity, makes its pathogeny and therapy of extreme interest to the physician. Before any rational treatment could be instituted against the excessive formation of fat, or for its destruction, the labors of Justin N. Liebig were necessary. The work of Liebig was enlarged in later years, so that today it is definitely determined that fats are formed from nutritive materials—albumens, fats, and carbohydrates. Now, in order to produce obesity, these fat-forming substances must be ingested in such quantities that it is absolutely impossible for them to be used up in physiological processes for the development of force and heat, and hence, having become superfluous, they are changed into fat and stored in the tissues.

56. The fat-forming substances may be taken in normal quantities, but for various reasons they are used only to a slight extent in the physiological processes of the body, and are deposited as fat in large amounts in the tissues. These constitute the chief etiological factors in the production of obesity; namely, the ingestion of a normal quantity of fat-forming materials, and failure of the system to utilize them in the physiological processes of the body, or the ingestion of too large a quantity of fat-forming substances, so that it is absolutely impossible under any conceivable conditions to utilize them in the production of heat and force.

57. Plethoric and Anemic Corpulence.—Two typical forms of corpulence are met with in practice—the plethoric and the anemic forms. These two forms differ materially in the quality and quantity of the blood that constitutes the basis for

the increased development of fat. The plethoric form is more common in men, and is characterized by a full strong pulse, redness of the face, increased vascularity of liver and lungs, hemorrhoids, increase of the hemoglobin and of the number of red corpuscles.

The anemic form is most frequently met with in women, and differs materially even on superficial observation from the plethoric form. The difference of appearance has for its basis changes in the quantity and quality of the blood, anemia and chlorosis. Both forms terminate in the same condition of the blood; namely, hydremia. In the anemic form, hydremia may be and usually is established at an early period; but in the plethoric form, years elapse before any evidence of hydremia becomes manifest. The anemic form is characterized by pallor of the face and of the visible mucous membranes. It is accompanied by many of the symptoms of neurasthenia, headache, vertigo, loss of memory, inaptitude for work (mental or physical), languor, palpitation, dyspnœa, edema. Examination of the blood shows diminution of hemoglobin and a decrease in the number of blood-corpuscles. Many patients will present themselves in whom these symptoms are commingled, constituting what may be called transition cases. In any of these forms the accumulation of fat first shows itself by an increase in the sites of normal deposits. The panniculus adiposus is increased in thickness, the malar regions fill out, a double chin is gradually formed, the breasts and abdomen rapidly assume increased dimensions, and the general contours of the body are increased.

58. Heart-Action.—Of the internal organs the heart suffers most. The deposition of fat beneath the pericardium and between the muscle-fibers of the heart interferes with the free action of the heart, and with the nutrition of the cardiac muscles, and as a result this fatty degeneration of the muscle-fibers takes place. It must be remembered, however, that fatty degeneration of the heart-muscle occurs much more frequently in emaciated persons as a result of prolonged mental labor, accompanied by worry and anxiety. In obese subjects the

nutrition of the heart-muscle is interfered with by the deposition of fat, and is distinctly a secondary phenomenon. The fatty heart of the emaciated admits of an entirely different explanation. The liver and the lungs are filled with blood, and their functions are seriously altered. The respiratory movements are limited, and bronchitis is common. Asthma is prone to occur with feeble heart-action, and fatal cases of dyspnœa may result from blood-stasis or edema of the lungs.

59. Hyperemia of the Liver.—The hyperemia of the liver develops catarrh of the stomach, dyspepsia, and chronic constipation. Interference with the function of the kidneys is shown by the diminished quantity of urine containing albumen and also by edema of the extremities. The condition of the blood, producing alterations in metabolism and nutrition that causes obesity, predisposes also to arterio-sclerosis, with all its consequent evils. The first symptom usually complained of by an individual in the incipient stage of obesity is dyspnœa coming on after ordinary exercise. This dyspnœa continues to increase until finally it is a constant symptom, being present when the patient is trying to rest, and very much exaggerated on the slightest exertion. The pathology of obesity is explained by interference with the free play of organs, and its necessary result on the circulation in the organs of the body, and altered or retarded nutrition due to these causes and the quantity and quality of the blood. About one-half of the cases of obesity develop diabetes. Obesity may be considered as a disease due to retarded nutrition and belonging to the same family as megrim lithiasis biliary, gravel, asthma, articular rheumatism, gout, and diabetes.

TREATMENT.

60. According to the pathology of obesity there are two chief indications for treatment; namely, diminish the amount of food to be oxidized, and increase the oxidation of the fat in the body. The first indication is provided for in a prepared dietary from which the carbohydrates are excluded. The second

indication is contended against by exercise, such as walking, mountain-climbing, gymnastics, massage, and electricity.

Various drug remedies have been used at different times, but with no encouraging results. Some drugs, while they reduce the fat-accumulation, interfere so much with the general health that their utility is extremely problematical. Among the drugs used the following may be cited: iodids, mercurials, phytolacca, and the alkalis. A treatment at present in vogue, and that seems to a certain extent useful in selected cases, is the use of Vichy and Kissingen water on alternate days after each meal. Thyroid extract has been administered with reported successes.

61. Uses of Static Electricity.—The general nutritional uses of static electricity include the mild alterative action of positive electrification, the more energetic method of interrupted static current called potential alternation, and sparks to the general muscle surface of the body. The local symptoms call for the same local methods as similar symptoms in other cases. Counter-irritant frictions are useful on the spine, over the hepatic region and also (with caution) upon the anterior respiratory muscles. A stimulant spray over the region of the heart is both safe and beneficial in all cases of weak heart. In special local deposits of fat, apply a small sponge-covered electrode and connect it to the positive pole. Ground the negative pole and use a rapidly interrupted static current in the form of local potential alternation for 10 minutes. This may be repeated three times a week. The great benefit of static treatment will not be seen in a direct reduction of weight but in assisting the patient to tolerate the weight with comfort.

SPECIAL INFECTIOUS DISEASES.

62. General Consideration.—When the symptoms that characterize a disease disappear, and when its essential lesions are in process of repair, convalescence may be said to be established. *Convalescence* is usually understood as a period of varying length following diseases that affect the general health. For the acute infectious diseases it may be said to begin when defervescence is complete, although the anatomic

lesions may persist for some time longer. The course and duration of convalescence depend on the gravity of the disease, on the treatment used, on the age and strength of the patient, and on the condition in which he lives.

The influence of the disease on the convalescent stage will be governed by the intensity and duration of the fever and by the amount of organic waste. A short attack of cholera may produce an adynamic state more profound and requiring a longer convalescence than typhoid fever. After a severe attack of typhoid fever, even when there are no complications to interfere with the natural course of convalescence, it is a question of months before the patient's tissues or organs can be regarded as normal. The temperature is slightly less than normal, the pulse somewhat slower, reflexes are exaggerated, vertigo and palpitations are frequent, the muscular system is weak, and there is inaptitude for work, mental or physical. In this constitutional condition, an emotion or an error in diet are sufficient to produce grave accidents, while in the robust individual their influence would not be felt. During convalescence all the tissues of the body are below normal and therefore in a condition to become the seat of morbid processes. The hereditary predisposition of the patient should be carefully studied, because convalescence is a condition of increased vulnerability, and any disease to which the patient is disposed from birth is apt to declare itself.

63. The relation of static electricity to certain stages of recovery from acute infectious diseases should be fully understood. We have shown in this Section that its value is underestimated by the general profession, and that the neglect to employ its properties is a serious evil.

In all cases needing tonic treatment study the benefits of very mild and well-tolerated sparks on the chief muscles, the heart apex, region of the liver, the abdomen, and upper spine; also spinal frictions and gentle stimulation to the respiratory apparatus. The best results are obtained when the usual tonics are reenforced by judicious static electricity, and physicians who for the first time observe the superior effects procured will find our teachings invaluable in this large class of cases.

TYPHOID FEVER.

64. As soon as the patient has reached the point at which the therapeutic suggestions of textbooks usually end, static electricity is ready to begin its great work of preventing or removing sequelæ and restoring tissue resistance to par. "The lower tone of cell life, favoring the successful implantation of the tubercular bacillus," is also a source of debility and danger in other ways until recovery of strength is complete. No other agent can so shorten a lingering convalescence as static electricity. Administer it by the great tonic methods—potential alternation and mild sparks.

MALARIAL FEVERS.

65. When convalescence from the acute disease tends to drift into the chronic malarial cachexia, and the patient is debilitated, depressed, and anemic, the action of indicated remedies can be so greatly reenforced by static electricity as to often gratify both the physician and his patient. Employ potential alternation, counter-irritation to spine, and sparks over spleen and liver, as well as to the general muscular system.

MEASLES.

66. The complications and sequelæ of **measles** may be more serious than the original disease. Whenever convalescence to a full return of tissue resistance progresses less rapidly than desired, the child should have the benefit of the rapid tonic action of static electricity. An ounce of precaution is worth a pound of cure. Use positive electrification.

With reference to this disease and all of this class the use of static electricity is to treat the patient as the indications present suggest. The actual disease is not treated by the current, but the local and general conditions of the patient call for certain alterative, or tonic, or nutritional, or other therapeutic actions, which selected applications of static electricity can readily set up in the tissues, if used as taught. Add to positive electrification any form and dosage of breeze, spray,

frictions, or sparks that are needed to make the treatment thorough and efficient. This applies to measles, scarlet fever, diphtheria, grippe, and every acute febrile disease, and is emphasized here so that it need not be repeated under each head.

SCARLET FEVER.

67. The anemia, prostration, tendency to nephritis, and other sequelæ of **scarlet fever** in its severe forms, render the full restoration of normal tissue resistance of urgent importance to the child. A tedious convalescence can be greatly shortened by employing static electricity at as early a date as the patient can safely attend the office for treatment.

DIPHTHERIA.

68. The paralytic, renal, and cardiac sequelæ of many cases of **diphtheria**, and the prostrating and anemia-creating nature of this disease, make its stage of slow convalescence a period of great detriment to the child. No remedy that will take tedious months from this often anxious period can justly be neglected by the physician. The rapid progress to complete recovery under static administrations is one of the most satisfactory things in medicine. Its use should begin as soon as the patient can safely attend the office.

INFLUENZA, OR THE GRIPPE.

69. The peculiarly slow return of full working-strength in **influenza** is often one of its annoying features. Both mind and body are often depressed for weeks and months, and complications of serious but latent chronic diseases are often turned into active and fatal processes. As a result of the grippe, diseases of the heart, lungs, and kidneys, that had been scarcely discoverable, have taken on rapid action and become grave affections. The toxic principle of influenza seems to have a special affinity for the nervous system. In one type of influenza the symptoms are all referable to the nervous system; but in all cases of influenza, the subsequent weakness and prostration

are out of all proportion to the original malady. The affinity of influenza for the nervous system, and the frequency with which it produces functional nervous disorders of a depressing type, should always be considered in treatment. When influenza attacks individuals with a neurotic taint, unless it is properly treated, functional nervous disorders are likely to follow the acute attack. During the acute attack the treatment should be directed to mitigating the effect of the influenza-poison on the nervous system. Cardiovascular and cerebrospinal depressants are avoided altogether or used with extreme caution. The indications are to promote elimination of the toxic principle, and to support the vitality of the patient. Were the value and physiological actions of static electricity properly understood by the medical profession, every grippe patient would be sent to a static machine as soon as he or she could safely get out of doors. Its tonic, restorative, and function-regulating properties are of vital importance when convalescence halts. Employ the tonic methods of potential alternation and spinal spray. Especially meet local respiratory and cardiac indications for counter-irritant spray and mild sparks.

DYSENTERY.

70. The exhausted condition in which **dysentery** often leaves the patient makes the value of static electricity during convalescence exceed that of any other measure save regulation of the diet till recovery is complete. Any of the forms of dysentery may also become chronic. Though ulceration of the mucous membrane is the most common lesion, yet ulceration may be absent, or it may have a tendency to heal. "The topical treatment," says an authoritative writer, "of chronic dysentery by way of the rectum is that on which most reliance is placed at the present day." Nitrate of silver, alum, zinc sulfate, cupric sulfate, and plumbi acetatis are used in solution as an enema. The same author confesses to disappointment in the results, as he says: "My cases improved to a certain point, but none got well. The treatment is sometimes painful."

71. Tyson says, "Very decided counter-irritation to the abdomen by iodin or even by blisters is sometimes of decided benefit. At least these measures seem to mark the turning-point in the disease." This is an important statement, for not only is the counter-irritant action of static frictions and sparks over the abdomen and spine about the most energetic and efficient known, but deep reflex and nutritional actions are added to the counter-irritation. They have none of the draw-backs of the medicated enema. A young soldier of the Spanish-American war returned from Puerto Rico with chronic dysentery on September 28, 1898. He had lost 20 pounds, his stools were ten per day, and his prostration was extreme; he could hardly keep on his feet, and remained in bed nearly all the time after arriving in New York. Treatment was begun on October 7, the general tonic method of potential alternation being used, followed by a rapid spark-treatment on the general muscles (to impart strength) and active counter-irritation over the abdomen and on the spine. When first seen, his cadaverous appearance and debility were striking. After the first séance he went home and to bed and slept 4 hours, awaking refreshed. On October 10, his fourth treatment found him greatly improved in general energy, courage, and mental state. On October 12, he reported but two stools instead of ten or twelve, and tenesmus gone. He was treated daily, made rapid gains, and in two weeks was able to walk miles, eat a mixed diet, and his mental depression was changed to a hearty and hopeful state. On November 7, he obtained employment, "in better general health than he had been since boyhood," while his comrades that returned on the same ship were still suffering from the exposure and bad food, even those that escaped actual disease.

SYPHILIS.

72. In the treatment of **syphilis**, most authors point out the value of tonic remedies, nutrition, and a favorable climate—not as specifics for the virus, but often not less valuable and necessary than mercury and the iodids. The arguments in their favor are also arguments for the special uses of static

electricity in syphilis. It is tonic, nutritional, antianemic, relieves many distressing symptoms, and moreover renders more active the mercurials in the system. There is no doubt of this, for old cases of syphilis that had not taken mixed treatment for 5 years were found to become slightly salivated while undergoing static treatment for other conditions, the aroused functional activity having probably set free the drugs locked up in torpid glands. The indications present in each case must govern the methods employed, and these may be any two or more of the entire resources of this agent.

DISEASES OF THE RESPIRATORY ORGANS.

ACUTE FLUENT CORYZA.

73. Acute fluent coryza is an inflammation of the nasal mucous membrane. It may result from the action of chemical or mechanical irritants, but is usually the result of "taking cold." When in the stage of serous discharge, it is amenable to the drying and sedative action of the positive static spray. Apply the spray to the sides of the nose and over the frontal sinus until hypersecretion ceases. Also have the patient alternately stop one nostril while forcibly inhaling the spray through the other. If not exposed again to bad weather immediately after treatment, one application suffices. If the case has advanced beyond the serous stage, the same treatment aids the action of other remedies prescribed, and often greatly shortens the duration of the cold. Repeat daily till relief is permanent. In the aged, or those debilitated from any cause, the liability to complications brought on through sudden changes of temperature must be remembered. Indeed, in these cases, any treatment adopted is best carried out in the patient's home. A fatal attack of pneumonia may result from the exposure unavoidable in a trip from the patient's home to the doctor's office.

HAY-FEVER.

74. Hay-fever is a catarrhal neurosis of the mucous membrane of the eyes, nose, mouth, pharynx, larynx, and bronchi,

with aggravations of dyspnœa induced by peculiar causes in individual cases. The theory that pollen-grains of plants carried in the air and inhaled cause hay-fever has given this disease its name, but many other causes are known. Excessive irritability of the mucous membrane is the predisposing condition. Any rational treatment of hay-fever must be preceded by a careful examination of the interior of the nose and nasopharynx. If any pathological condition is found to exist in these cavities, the first indication in treatment is to remove this condition if it is possible. The treatment of pathological conditions in the nasal cavities may be either medical or surgical. The pathological state is chiefly expressed by the term "irritable coryza," and medicinal treatment consists in allaying the local irritation and in combating the general predisposition by tonic measures. It is not possible for every one to change his residence during the season of hay-fever, but in any location in which the exciting cause is absent the trouble quickly abates. The sedative-tonic action of static electricity makes it the foremost remedy known. Apply a strong sedative-tonic spray to the spine and head. If the patient is debilitated, employ potential alternation as a general tonic also. To the surface over all the irritable mucous membrane, apply a sedative-tonic spray, gradually increased in intensity until it warms the skin and slightly reddens it, producing a mild rubefacient effect. If some dyspnœa is present, apply a few mild positive sparks to the muscles of the chest, and repeat daily until relief is secured.

CHRONIC LARYNGITIS AND PHARYNGITIS.

75. Chronic laryngitis and **pharyngitis** require the same treatment, so far as static electricity is concerned. It must be employed in one of two ways, and its action is diffused through the tissues. The character of inflammation amenable to the vasoconstrictor or counter-irritant action of the two methods of static treatment available is the simple chronic lesion following acute attacks, or irritation or overstrain of the vocal organs, dry in form, and characterized chiefly by muscular soreness, hoarseness, irritative cough, and occasionally difficulty

in swallowing. Ulcerations, tuberculosis, syphilis, and tumors of the larynx are excluded.

Method 1.—Apply an ordinary moist sponge-electrode to each side of the larynx. Pass a rapidly interrupted fine Leyden jar current directly through the tissues, and regulate the dosage to comfortable tolerance, making the duration of the séance from 5 to 8 minutes. Avoid fatigue of the parts, and repeat three times a week.

Method 2.—Apply a stimulating and mildly counter-irritant spray to the external parts, interspersed with a few small muscle-contracting sparks. Repeat three times a week.

TRACHEA.

76. In ordinary medical practice the **trachea** seldom presents disease except in association with affections of the neighboring parts. When non-febrile cases complain of tenderness, soreness, sense of constriction, pain or difficulty in breathing, and refer to the situation of the trachea, relief is promptly afforded by a sedative-static spray in subacute cases, and by mild counter-irritation in chronic cases without soreness. Organic lesions, tumors, malformations, stenosis, ulcerations, and other possible diseases of the trachea do not come within the scope of static electricity.

BRONCHITIS.

77. Cause and Nature.—The type of **bronchitis** that may be benefited by static electricity is the chronic form occurring in the adult. It may result from an acute attack, or it may be associated with chronic disease of the heart and lungs. It may be dry, or mucopurulent expectoration may be abundant; dyspnœa, oppression behind the sternum, irritation in the throat, pains, and general nutrition or debility may vary greatly as the patient advances in age or the disease progresses in severity. The therapeutic principles underlying the use of static electricity are the same as those governing the use of drugs.

Bronchitis is an inflammation of the mucous membrane lining the bronchial tubes. It may be acute, subacute, or

chronic. The air-cells are not affected except as a complication. In chronic cases the mucous membrane becomes more or less irregularly thickened, emphysema gradually develops, and the tubes become irregularly dilated. As an independent primary disease it is bilateral, but may be local as secondary to tuberculosis, aneurism, traumatism, tumors, or cardiac and other diseases.

78. Treatment.—Standard works on drug therapeutics provide from fifty to sixty remedies for bronchitis in general, of which about fifteen are prescribed in chronic cases. The carbonate and chlorid of ammonia, creosote, guaiacol, iodin, iodid of potassium, ipecac, sanguinaria, senega, squill, strychnin, terebene, codein, and other preparations of opium are most commonly employed. All the efficiency of any of these remedies must be employed for grave cases, together with suitable nutrition, hygiene, and climatic precautions; but in all gradations of severity, the action of familiar agents may be supplemented by static electricity with increased benefit. Its use is directed primarily to the relief of symptoms, and secondarily to the upbuilding of local and general tissue resistance. For this latter purpose potential alternation is a useful general tonic. A tonic spray should be applied to the spine and alternated with mild positive sparks to the general muscular system. The direct treatment of the chest consists of a strong spray made sedative or counter-irritant according to the indications, and the occasional intercurrent use of mild sparks to strengthen the respiratory muscles and promote easy expectoration. The patient should avoid exposure to bad weather immediately after treatment.

PLEURISY.

79. Nature.—The cases of **plueritis** suitable for treatment with static electricity are subacute or chronic - localized and with little or no effusion. In these cases static electricity may properly supersede plasters, blisters, strapping, and external counter-irritants. It is efficient to relieve pain, promote resolution, restore respiratory energy, and improve the general

health. So-called dry pleurisy is a circumscribed inflammation of the pleura with thickening of the membrane and often adhesions of the opposing surfaces, resulting from the proliferation of connective tissue. It is often an extension of inflammation of the lungs, or may result from traumatism or exposure to cold, or the cause may be obscure.

80. Treatment.—Quick counter-irritation over the site of pain by spray or frictions, repeated two or three times, is effective. After relief of the pain, apply mild sparks to the adjacent muscles to restore mobility, if it has been reduced. Patients that are debilitated should also be treated three times a week with potential alternation until improved.

PNEUMONIA.

81. Pneumonia is an acute inflammation of the lung-tissue that is often associated with a state of lowered vitality. It leaves behind it a state of general debility. If resolution is not complete, a nidus for chronic disease exists. The pathology and treatment are not considered here, for the reason that static electricity does not deal with pneumonia, but with the patient that has recently had it. It is efficient in that it rapidly restores the general strength and relieves such local symptoms as remain. Positive electrification for 15 minutes is a useful tonic application. This can be merged into potential alternation, and soon supplemented by mild sparks to the limbs and spine to restore muscular strength. The respiratory muscles can be energized in the same way. In debilitated cases, the power of inspiration and expiration are apparently doubled by such treatments—sometimes by a single treatment. This improvement gradually becomes permanent during the course of a few weeks of regular and thorough treatment.

ASTHMA.

82. Nature of the Disease. — **Asthma** is a reflex neurosis, characterized by recurrent paroxysms of violent dyspnœa. The "wheezing" and paroxysms of dyspnœa are due sometimes to spasm of the muscular coats of the bronchial

tubes, sometimes to tumefaction of their mucous membrane from capillary vasomotor disturbance, and sometimes both of these conditions may be present. The spasms may be reflex from gastric or uterine irritation. The factors involved in an attack of asthma are three in number: (1) irritation; (2) a sensitive nerve-center; (3) a vulnerable area of mucous membrane. External irritants are dust, chemical vapor, vegetable irritants, animal emanations (a patient may not be able to go near horses), and climatic influences. It is also an expression of gout, syphilis, skin, and renal diseases. Heredity is traced in 40 per cent. of asthmatics. It has alternated with the subsidence of eczema, urticaria, and of psoriasis. It may affect all ages, but in childhood is most often a sequelæ of measles, pertussis, and bronchitis. The type of asthma may be chiefly "nervous," or chiefly "catarrhal," and as age progresses the tubes thicken, their muscular coats hypertrophy, emphysema develops and increases, and dilatation of the right heart is common. Asthmatic symptoms due to tumors of the mediastinal spaces, to aortic aneurism, to hypertrophy of the bronchial glands, and to cardiac and renal diseases are not considered here.

83. Treatment.—The two great indications are to avoid or remove the exciting cause, if possible, and to allay or prevent the attacks. Drugs employed are chiefly antispasmodic, either stimulant or sedative. Among special drugs that have been tested and found useful should be mentioned iodid of potassium, tincture of belladonna, tincture of lobelia, and strychnin. The concurrent testimony of standard medical therapeutists is that "asthma is one of the most difficult diseases to successfully treat that the physician has to deal with." Diet, hygiene, and atmospheric conditions should be carefully studied. The nose and nasopharynx should be examined for polypi and adenoid growths, which are a possible source of interference in breathing. To mitigate attacks at the time of the paroxysm, the physician will depend on his usual medication, but the curative treatment of asthma calls for other resources, and here he may gladly avail himself of static electricity.

"The curative treatment of asthma," says Hare, "rests to a very large extent on the use of iodid of potassium, and on the careful regulation of the diet and bowels." To appreciate the utility of static currents in all reflex neuroses and chronic impairments of nutrition, and to estimate the force it can add to medication, the student should study *Technique and Physiology of Static and Other High-Frequency Currents*. It should be regularly and persistently employed between the attacks, in conjunction with other measures, and by the following methods: Positive electrification or potential alternation should be employed, with counter-irritant spray and mild sparks to upper chest and spine. Nasal and throat complications require the same static method as that described for acute fluent coryza. The treatment (so far as it concerns static electricity) in cases of advanced emphysema, dilatation of the right heart, and tricuspid insufficiency does not differ from the above. Modifications of treatment in all chronic diseases must be governed by the individual case. They cannot be laid down in advance, for in practice the physician does not treat diseases by name.

PULMONARY TUBERCULOSIS.

84. Character of Disease.—The germ of **pulmonary tuberculosis** is Koch's bacillus planted upon a soil of vitiated vitality. From the consideration of static treatment may be excluded acute phthisis and stages of active inflammation, and also the complication of laryngeal phthisis. Chronic phthisis is clinically referred to in two forms—catarrhal and fibroid. The now well-known pathology of the common form, which usually commences in the apex, is an inflammation of the bronchioles and the formation of "tubercles," which are similar wherever found, and differ chiefly in color and consistence, according to age and the changes of a gradually destructive process. They are hard or soft, gray, white, or yellow, massed or disseminated, according to circumstances, but primarily there is but one tuberculosis.

A tubercle is avascular; necrosis is therefore its destiny. It does not undergo resolution, but cavities finally result, partly

by absorption, but chiefly by expulsion of broken-down tissue by coughing. The ulcerative process occludes blood-vessels, so that general infection through the circulation is rare. The disease extends along the air-passages from one point to another. It attacks both sexes at all ages, and anything that lowers vitality predisposes to it. Conversely, a high state of tissue resistance is the sovereign safeguard The symptoms and physical signs are not properly within the scope of this Section, which is restricted to the therapeutics of static electricity.

85. Treatment by this agent aims to support the powers of nutrition. Secondary and local effects are the relief of symptoms. The complete therapeutic chain must have regard to (1) personal hygiene; (2) food nutrition; (3) medication; (4) pulmonary gymnastics, and (5) static electricity and auxiliary measures. The curative action of drugs or climate is most confidently prescribed in the early stages of the disease. To any and all other measures of every sort, static electricity may be added without interfering, and with benefit. The methods of employing it are general and local The general nutritional methods are: tonic spray to the spine, tonic sparks to the general muscular system, potential alternation, and general electrification. In the local methods, the counter-irritant spray is employed, interspersed with short sparks to the foci of disease, chest and back, with the same application to throat for irritative cough, or rapidly interrupted Leyden jar currents through the larynx, and mild sparks on respiratory muscles to strengthen them. This treatment greatly increases the oxygen capacity of the lungs. In late stages, treatment may or may not relieve all the sufferings of the patient and does not check the progress very much; but in early stages, skilled static treatment is often curative and always creates improvement.

DISEASES OF THE HEART AND BLOOD-VESSELS.

86. Characteristics.—Organic diseases of the heart cannot be directly treated by static electricity. It bears a different relation to their pathology than is borne by digitalis, aconite, nitroglycerin, and drugs of other names that act on the heart.

In its physiological action it treats the patient by regulating functions and promoting nutritional energy. Any chronic disease of the heart must therefore be treated primarily by drugs, if a direct action on the lesion is possible, while static electricity may be prescribed for symptomatic relief, for its regulating and tonic properties, and as an efficient substitute for various extra-drug measures that are commonly advised. The prognosis is affected by the nature of the lesion, but the state of the patient furnishes the indications for static methods; hence, to repeat here the pathology of chronic endocarditis, myocarditis, hypertrophy, dilatation, fatty degeneration, and the eight varieties of valvular lesions would be superfluous. Positive electrification is a mild heart-tonic and regulator, and is never contraindicated. Potential alternation is a more energizing tonic and regulator, and is usually well tolerated. If, in a rare case, it disturbs the patient, it can be stopped. Sedative-tonic, stimulating, and counter-irritant sprays on the spine and over the region of the heart, according as they are indicated, are nearly always tolerated and beneficial, and are especially efficient in the relief of pains, distress in breathing, palpitation, and sense of weakness. Muscle-contracting sparks to the extremities are a great aid in advanced valvular lesions when patients are unable to take sufficient excercise; and they are still more valuable in earlier stages. They are rarely contraindicated when employed with proper skill. Edema of the lower extremities is relieved by Leyden jar foot-baths, and sparks to the muscles of the legs.

FUNCTIONAL CARDIAC DISEASES.

87. Palpitation, pain, irregularity, and syncope are the chief manifestations of functional derangement of the heart. The treatment of any one or all of them by static electricity follows the same superficial indications, and calls for the same methods as stated under organic diseases. It is impossible to take into account with this agent the refinements of textbook discriminations on the indications for a choice out of a hundred drugs. Clinical experience renders it unnecessary. The

important thing to remember is that, in functional disorders, static electricity is employed to regulate the heart-action, and in organic lesions to also regulate the heart and to counteract the effect of the lesion on the patient. The diagnostic name of any organic cardiac lesion does not indicate the treatment, but this is directed to counteract the pathological results of the lesion, according to their manifestations.

88. Diseases of blood-vessels chiefly interest the student of static electricity from but two points of consideration: (1) Will an improvement in general nutrition benefit the patient? (2) To what extent is the arterial disease a contraindication for any static method of treatment? Arteriosclerosis, atheromatous degeneration, endoarteritis, calcareous deposits, and aneurisms are not directly the subject of static treatment. It is important, however, to say that such degrees of these lesions as may be met in ordinary office-practice in patients attending for treatment of other conditions rarely contraindicate any measure that comes within the scope of skilled and cautious electrotherapeutics. The patient may be benefited also in general nutrition, and thus degenerative changes may be made to progress more slowly. Study the general tonic and nutritional methods described in *Technique and Physiology of Static and Other High-Frequency Currents.*

DISEASES OF THE BLOOD AND BLOOD-MAKING ORGANS.

89. Anemia and chlorosis are the only two states for consideration with reference to static electricity. General nutritional measures (uniting the usual drugs with blood-making food) and static electricity complete the therapeutic chain. Static electricity is rarely employed for anemia only. Its range of action is much wider, and anemia *per se* would not be treated in the best manner by static currents alone, although in clinical experience many cases of marked chlorosis or anemia make rapid recoveries with no other treatment. In private practice the rule is to prescribe iron, arsenic, etc. at the same

time that electricity is employed. The methods are general positive electrification, potential alternation, or general sparks to the muscular system, spine, liver, and spleen.

DISEASES OF THE THYROID GLAND.

90. Exophthalmic goiter is perhaps the only enlargement of the thyroid gland that demands consideration with reference to static electricity. The well-known characteristics are the goitrous enlargement of the thyroid, the exophthalmus, rapid heart-action, and the excessively nervous state. The direct treatment of the condition includes rest, sedation, cardiac regulators, and the galvanic current. Static electricity has been employed by some as an adjunct to galvanism, for its sedative action on the terrible "nervousness," but great importance has not been usually attached to it. Certain facts, however, point theoretically to its being a much more rational and direct remedy than has been appreciated. The view of the disease now chiefly accepted as best explaining the nervous symptoms is that it is a sympathetic neurosis. It is most frequent in neurotic heredity or neurotic states. Worry, grief, mental or physical overtax, mental shock, and acutè exhausting diseases are ascribed as exciting causes. Hence, the predisposing and exciting causes and supposed lesion of Graves's disease all point to the physiological actions of static electricity. It must be employed by general and local methods directed to symptomatic improvement. Among local measures, employ the potential-alternation current, localized on the enlarged gland; also use a sedative spinal spray.

DISEASES OF THE EYE AND EAR.

91. As an adjunct to local measures for the direct treatment of eye and ear affections, static electricity is of value to the patient in many cases associated with debilities and functional disturbances. Mental states may be improved, headaches relieved, and nutritional vigor stimulated, in ways

that are usually neglected with this class of patients. The state of the eyes that can be directly benefited by static electricity is the common form of asthenopia dependent on debility, temporary illness, anemia, advancing age, or overuse. Carefully apply a warming and close spray (without needle-sparks) to the frontal region around the eyes until a slight rubefacient effect is secured; add counter-irritant spray or frictions on the cervical spine The pain and acute congestion caused by a draft of cold air, cinder in the eye, or slight injury may be at once relieved by a sedative spray upon the closed eye. Avoid giving a careless spark. After the removal of small foreign bodies, the irritation of the conjunctiva can be quickly allayed in the same manner. Excessive secretion of the lachrymal glands and even occlusion of the lachrymal duct may be greatly improved by a few static treatments. Simple ophthalmias and conjunctivitis may be improved in the same way. The effects of the application are very satisfactory to the patient, if proper skill in technique is employed. Recent experience demonstrates that static electricity has a wider range of usefulness on the eye than was supposed possible two years ago.

DISEASES OF THE DIGESTIVE SYSTEM.

NERVOUS DYSPEPSIA.

92. Nervous dyspepsia is the gastric expression of neurasthenia, as is also atonic dyspepsia. Both of these conditions require reestablishment of muscular and nerve tone. The usual dietetic advice and medication may be practically supplemented by the general static treatment of neurasthenia, with the addition of a stimulating spray to the abdomen and spine. If well tolerated, mild sparks gradually increased to vigorous sparks on the abdomen may follow the spray. The chronic sufferer from nervous dyspepsia can be made very grateful to a skilfully handled static machine If it does not quickly produce benefit, an incomplete diagnosis is probable.

GASTRALGIA.

93. Cause.—Gastralgia has no discoverable organic lesion as a cause. It may be due to more than one cause, but it is difficult to say what causes the intermittent paroxysmal pains. Before considering treatment, the diagnosis should be carefully made.

94. Prognosis.—Attacks may be moderated, lessened in frequency, or may cease altogether under medical treatment; or in some cases the attacks may recur throughout life. Some authors state that the severest attacks of gastralgia can only be relieved by morphin, and the facility with which it may be used is very great; but not only may ordinary attacks be relieved at the time by static electricity, but curative effects rapidly result from frequent and energetic treatment. Static electricity can make the prognosis good as to a cure; or if the pains recur after a long period, a little more treatment again gives an interval of immunity. Not only do the pains cease, but the patient ceases to worry for fear they will return. The danger of contracting the morphin-habit is removed. The general health of the patient gains material benefit. If these results are not obtained after reasonable and proper treatment, an error of diagnosis may be suspected.

TREATMENT.

95. Treatment by static electricity consists in anodyne and counter-irritant sprays over seat of pain and spinal centers, and counter-irritation by frictional sparks, followed later by long sparks, over the abdomen and spine. Also consult general indications for potential alternation or other constitutional measures. The patient should be treated daily at first, and regularly until dread of recurring attack ceases, when it may be occasionally repeated about the time attacks would be due.

ANOREXIA NERVOSA.

96. Characteristics.—Anorexia nervosa is a condition described in works on "Practice," in which "absolute loss of appetite" is the basic symptom. The results are great debility,

shortness of breath, vertigo, headache, constipation, and emaciation in proportion to the deprivation of nourishment, and in women amenorrhea.

TREATMENT.

97. As the usual bitter tonics sometimes fail to restore appetite in true cases of this state, and as the forced feeding by tube or rectal enemata is a reluctant resort, the simplest and best remedy is static electricity applied so as to improve both the nerve-centers and the peripheral apparatus. Simple potential alternation is a suitable basis of treatment, followed by judicious stimulation in the form of spray to the spine and region of the solar plexus. After a few séances, mild sparks supplement the spray and increase the benefit.

CHOLERA INFANTUM.

98. When convalescence does not progress under the usual management, and it is important to rally the functional forces out of their extreme prostration so that they will respond to remedies and retain nourishment, it is well worth a trial to put the child in the arms of its mother or nurse on the static platform, and subject it to the tonic action of positive electrification for 20 minutes and repeat every few hours until the child is out of danger. It can do no harm, and the proposition is physiologically sound. Its value has been demonstrated in practice.

CHOLERA MORBUS.

99. The acute prostration of **cholera morbus** (in severe cases) may be succeeded by a slow convalescence under common medical management or neglect on the part of the patient. To obtain a short, quick, full measure of recovery, no other treatment is needed during the convalescence than judicious diet and static electricity. The latter should be employed daily for a week or 10 days. The general tonic methods of positive electrification and potential alternation are indicated, together with local tonic methods of mild sparks to the spine, abdomen, and muscles of the extremities. The physician that has once

witnessed the effects of proper static treatment in severe cases will hardly again omit it from his armamentarium.

CONSTIPATION.

100. The entire subject of **constipation,** etiology, and treatment is too vast for discussion in this Section, which is restricted to teaching the therapeutics of static electricity. It may be briefly stated that in cases due to deficient secretion, inert peristalsis, muscular atony, or neurasthenic debility, one of the simplest and most curative, but not the most pleasant, remedies consists of sparks over the abdomen, spleen, liver, and spine, with particular attention to the region of the solar plexus and the lumbar centers. Careful teaching in the technique of dose-regulation and the handling of the spark-electrode will avoid most of the annoyance to patients.

NERVOUS AFFECTIONS OF THE BOWELS.

101. Characteristics. – Nervous affections of the bowels take the form of an increase or diminution of the functions of motor, sensory, or secretory nerves, and the manifestations described are (1) nervous derangements of motion, causing constipation, colic, or diarrhea; (2) nervous derangements of sensibility, causing enteralgia, rectal neuralgia, or anesthesia; (3) secretion neuroses.

TREATMENT.

102. To the usual medical recommendations of carminatives, anodynes, laxatives, and sedatives are added counter-irritation to the abdomen by mustard or turpentine, stupe, and massage. These, as well as the nervous origin of the symptoms, indicate the superiority of an agent that can be made a nerve-sedative, tonic, stimulant, counter-irritant, or muscle-contractor, as the physician desires, without removing any of the clothing or troubling the patient with mustard, turpentine, or massage. Apply positive or negative spray, frictions or sparks over the abdomen and to the entire spine, regulating the dosage and therapeutic action to meet the indications. It does not interfere with other measures, but often renders them unnecessary.

DISEASES OF THE LIVER.

103. The direct relation of static electricity to diseases of the liver is a very slight one. It can be made to influence the hepatic circulation, can probably stimulate functional activity, can allay ordinary distress or pain referred to the region of the liver, can lessen the tendency to gall-stones, and in these and other ways can supplement other medical treatment and often make it more efficient. The direct applications of the static current to the region of the liver and gall-bladder may be either spray, frictions, or sparks. The therapeutic actions may be sedative, anodyne, stimulating, or counter-irritant, as the indications of the case require. In grave organic changes of the liver, this agent is, of course, inadequate; and in functional derangements of the liver, electricity is less important than in derangements of the nervous, circulatory, and muscular symptoms. The physician should study the limitations of static electricity, and prescribe remedies to complete the needs of the case, or disappointments will occur that could be easily avoided.

DISEASES OF THE NERVOUS SYSTEM.

104. Value of Electricity in Nervous Diseases.—The physiological action of static electricity on nerve- and muscle-tissue differs so materially from that of galvanic currents that its uses in nervous diseases rest on a different basis. As a muscle-contractor, the static current is less efficient than the galvanic in certain nerve-degenerations, and more efficient when the faradic reaction is maintained. As a rapid, general counter-irritant, it is more useful than other currents, while its other properties are often of peculiar value because the patient need not undress. In office-practice, nervous diseases may be divided into two classes; viz., (1) those that can be indirectly benefited by static electricity by treating the patient, and (2) those that have special indications for direct treatment within the scope of action of static currents. Another classification is (1) organic, (2) functional; but the situation of the lesion and the circumstances of the patient also influence the

selection of static electricity and the method of its employment. It is an agent to be used with skill and discretion rather than by hard-and-fast rules. Students should remember this, and study to perfect themselves in technique, as taught in the *Technique and Physiology of Static and Other High-Frequency Currents*.

Diseases of the nervous system in which static electricity will usually afford only symptomatic palliation or indirect benefit to the patient will first be considered.

EPILEPSY.

105. Causes.—Epilepsy is a chronic functional disease without ascertained pathology. It is characterized by periodical seizures of loss of consciousness or convulsions of different degrees of severity that are grouped into minor and major attacks: *petit mal* and *grand mal*. Heredity, parental insanity, alcoholism, intermarriage of neurotics, syphilis, extreme emotional disturbances, and obscure causes figure in the etiology. From ten to twenty years of age is the impressionable period. An epileptic attack coming on for the first time between the twenty-fifth and fiftieth year is due to syphilis, and should be so treated. A form of partial epilepsy affecting a single group of muscles or a limb is called *Jacksonian epilepsy*. In idiopathic cases there is found a degeneration of the cortical nerve-cells and a proliferation and increase in the neuroglia tissue in special areas of the cortex.

TREATMENT.

106. In every case of epilepsy a diligent search should be made for some exciting cause—for some pathological condition that may underlie the disease. The removal of this condition may cure the epilepsy. The direct treatment of epilepsy is mainly medical and hygenic. Static electricity is a useful adjunct with which to combat drug depressions or relieve local symptoms, and in a few recorded cases has apparently abated the attacks. It should be employed by sedative-tonic methods, of which potential alternation, positive spinal, and head-breeze are of demonstrated value.

PARALYSIS AGITANS.

107. **Paralysis agitans,** or shaking palsy, is a chronic nervous disease marked by a characteristic tremor. There may be also muscular rigidity and weakness, and symptoms of neurasthenia. It rarely occurs in early life, and the causes are obscure. The direct drug and hygienic measures embrace mostly sedatives, tonics, and narcotics. The mind is often in an emotional state, the patient crying easily, or being depressed, or partly hysterical. Some have severe headaches. For the emotional state, headaches, depressed nutrition, muscular debility, insomnia, etc., static electricity possesses approved value. Besides potential alternation as a general tonic, the sedative head-breeze, spinal sedation, and counter-irritation, and occasional general tonic sparks confer decided benefit. It is not customary to promise relief from the tremor, though improvement may be obtained.

SPASMODIC WRYNECK.

108. **Spasmodic wryneck** is a nervous disease distinguished by spasms of the muscles supplied by the spinal accessory or upper cervical nerves. A curve is rare. The disease is chronic but not progressive. Drugs, mechanical devices, surgery, and many suggestions contained in textbooks may be studied for some means to rest the patient and relieve or reduce the fatiguing tension upon the system. Static electricity, by means of spinal and local counter-irritations, followed by a sedative spray and head-breeze, produces grateful restfulness and secondary benefits of a tonic nature. The abuse of the patient by sparks on the affected muscles should be avoided.

SPINAL SCLEROTIC DEGENERATIONS.

109. Chronic myelitis and sclerosis following injury to the spinal chord, and multiple, lateral, and posterior sclerosis and progressive muscular atrophy are the familiar lesions in this class. As static electricity will not cure any of them, its value may be underrated, but at some stage of the disease the

patient cannot be regarded as having received the best aid of scientific medicine unless static electricity enters into his therapeutics.

CHRONIC MYELITIS.

110. Chronic myelitis, as it follows acute inflammation, injury, or softening of the spinal cord, is usually a mixed process containing elements of reparation and destruction as well as of inflammation. It may be primary or secondary, or may be due to compression. Exposure, syphilis, mineral poisons, infectious fevers, and traumatism are the chief causes. After a long period of slow degeneration and partial improvement, the disease progresses, paraplegia becomes complete, the legs atrophy and contract, and renal and other complications become a menace to life. Many times, during the slow course of this disease, the patient may derive local or constitutional benefits from static electricity. Methods may be directed to the symptomatic indications, and here again the study of the principles on which the drug therapeutics are selected will aid the proper selection of electrotherapeutics.

MULTIPLE SCLEROSIS.

111. Nature.—Multiple sclerosis, the development of sclerotic patches in different parts of the brain and cord, is a chronic and progressive disease, producing paralysis, tremor, disturbances of speech, and various cerebral and spinal symptoms depending on the seat of the lesion from time to time. The paralysis is often paraplegia. Traumatism and infection are the chief causes, and it occurs in the first half of life. It is not so severe or fatally progressive as some of the other cord-diseases, and a remission or improvement may be hoped for under combined treatment.

TREATMENT.

112. Study all measures employed in chronic diseases of the nervous system. Iodid of potassium, arsenic, quinin, hygienic measures, hydropathy, and a regular, quiet mode

of life, and the use of tonics are among the therapeutics recommended, as also is electricity All these indicate the probable usefulness of so tonic sedative and strengthening a remedy as the static current. In addition to general tonic electrification, select local methods according to symptoms needing relief.

SPINAL SCLEROSIS.

113. Kinds.—The treatment of **lateral spinal sclerosis,** or spastic spinal paralysis, involves mechanics and attention to nutrition. As an aid to the usual measures of maintaining nutrition during orthopedic practice, the decided action of static electricity and the facility with which it may be employed, despite clothing, braces, and other appliances, merits the study of the physician. Some observers have reported a type called the "*combined sclerosis* of pernicious anemia and cachectic states." The method of treatment advised strongly points to the use of static electricity as an auxiliary measure. The progressive degeneration is associated with very profound anemia, general muscular emaciation, and diarrhea, ending in a paraplegia. Quinin, arsenic, iron, bone-marrow, suprarenal-capsule extract, nourishing food, and stimulating air are recommended. All of these tonics can be reenforced by the tonic and nutritional actions of static electricity.

Posterior spinal sclerosis is also called *tabes dorsalis* and *locomotor ataxia.* It calls for fuller consideration than some other spinal diseases. It appears rarely in early life, being most common between the ages of thirty and fifty. Syphilis has coexisted in a large percentage of cases, but the causes that start into action the spinal degeneration are both various and difficult to trace. As the patient passes slowly from the earlier stages into ataxia and paralysis, it is the chief concern of the physician to take the patient as he finds him, and endeavor to promote comfort and arrest the rate of degeneration. In the early stage, cases of apparent cures are reported. In the second stage, the patient may pass many years with the aid of intermittent treatment. After that the measures that can be employed grow limited and of less effect.

114. Pathology.—The parts that undergo degenerative sclerosis are the posterior spinal ganglia, posterior roots, and gradually, and to a less extent, the peripheral nerves. The nerve-tissue of the white substance of the posterior columns disappears and gives place to connective and neuroglia tissue through which a few nerve-fibers may still be traced. There are also slight vascular changes. The segments first affected are those of the upper lumbar and lower dorsal regions. The changes spread upwards and laterally. The sacral cord is but little involved. Static electricity does not, however, directly attack and alter the pathological lesion, and its main utility is in the relief of symptoms and the improvement of general nutrition. When aided in this manner, nature may hold the degeneration in abeyance for a long time. An attempt will be made in the next paragraphs to indicate the symptomatic phases of locomotor ataxia in which static electricity is likely to be of value.

TREATMENT.

115. The drug treatment of the patient should be given careful consideration, and specific medication ordered in all cases of syphilitic history. Every drug recommended by some high authorities has been found wanting by others, and many patients decline to take medicine any more. The injurious effect of opium for the pains has been pointed out by various writers. Rest is urged as more important than drugs, but rest cannot always be commanded, any more than sleep when pain prevents. The galvanic current has an important place in the treatment of locomotor ataxia, but in this Section the static current only will be considered.

For the symptom of pain, static electricity is far more efficacious in many cases and in others far less injurious, even though it partly fails to give relief, than the anodyne drugs prescribed. Counter-irritant spray and modified sparks on the painful points and spine are preferred methods. For the symptom of insomnia, the general application of the static séance is usually beneficial. If it is a special feature of the case, apply a sedative breeze to the head. For the neuralgias of the

rectum and bladder, apply both sparks and a hot, counter-irritant spray.

For the constipation or diarrhea, whichever may exist, apply positive sparks over the region of the abdomen and lumbar spine. These act as a regulator of normal function.

For the numbness, impaired sensation, and sense of weight in the lower limbs, there is no remedy like powerful static sparks. They feel good. They do good, so far as any remedy applied at the periphery can do good, in the case of a central lesion. A fusillade of sparks 6 inches long, from which a healthy person would retreat as from the stabs of a knife, may be applied persistently to the sole of the foot in this stage of ataxia, and the patient will welcome the gentle and exquisite sensation, and will say that it warms and lightens his legs better than anything else he ever had done. These sparks do much to tone up the muscular weakness of any part of the body. They temporarily remove the sense of weariness and weight in the limbs, and they rapidly do much that is expected from the common advice to spend "sixteen weeks in bed." As a general nutritional tonic, potential alternation is a useful method. Leyden jar foot-baths sometimes improve the gait and are a useful variation of method. While the practical physician need not talk of curing his cases of locomotor ataxia, yet the prospects of checking the rate of progress and immensely increasing the comfort and possibilities of life for the patient are sufficiently good to justify the regular and persistent use of static electricity.

PROGRESSIVE MUSCULAR ATROPHY.

116. Cause and Nature.—Progressive muscular atrophy is a slow and gradual wasting of the muscles of the extremities and trunk, succeeded by paralysis. Atrophy of the cells of the anterior cornua of the spinal cord is the chief anatomical lesion of this disease, along with which are consecutive degenerative changes in the lateral columns, anterior roots, peripheral nerves, and muscles. The process extends down and up. The parts of the cord invaded are the lower cervical and upper dorsal, with later extension to the lumbar and sacral cord. As

the texture of the muscles affected changes from fiber into fatty, granular matter, the growing feebleness or loss of contractility of the muscle is the consequence of the atrophy rather than the paralysis of motor-nerve action. The atrophy is observed first in the upper limbs in a typical case. The ball of the thumb wastes, the interossei follow, and the hand becomes partly clawed. Once the limit of the hand and forearm is passed, the muscles of the arm and trunk waste irregularly and partially. Changes of form and attitude, and locomotor and functional difficulties develop from the gradual extension of the atrophy. The diaphragm and respiratory muscles are usually the last to be affected.

TREATMENT.

117. The essentials of treatment are rest, electricity, strychnin, powerful tonics, and overfeeding, quiet, and fresh air. Massage is useless. Medication is of little avail. The chief practical remedy is electricity. It is very nearly the only definite therapeutic agent in these cases. Static sparks have long been the sum of knowledge possessed about static electricity by many that employ it, and sparks are not the way to treat this disease. Sparks and stimulating frictions may be applied to the spine and to muscles not yet wasted by textural change, but the impaired muscles are preferably treated by the Leyden jar current or local potential alternation.

The rapidly interrupted nutritional current from small Leyden jars may be applied to the arm-, trunk-, or leg-muscles by the same method as local faradization. In the treatment of the leg or the arm, the Leyden jar bath is perhaps preferable. With frequent, persistent, and skilful treatment, the prospect of abating the disease for years is sufficiently good to urge the physician to give this current a thorough trial.

APOPLEXY.

118. Causes.—With the immediate lesions of the **apoplexies** static electricity has little to do, and as ordinarily employed it has but a poor record in the treatment of the late secondary conditions. The prognosis in the cases may be much

modified, however, and the general state of the patient improved by competent methods of employing static currents, and not merely sparks. Rupture of the blood-vessels supplying the basal ganglia, internal capsule, and white matter is the most common form of cerebral hemorrhage causing apoplexy; embolism or thrombosis plug the blood-vessel instead of rupturing it, but the results eventuate in symptoms like those of hemorrhage.

Repetition of etiology, diagnosis, primary symptoms, and treatment of the acute attack belong to other works on "Practice," as the consideration of static electricity in these cases only begins when the chronic state is established and the patient is able to come to the physician's office. Its function then is to combat the trophic changes, motor paralysis, pains, etc. of the affected parts, and to sustain general and local nutrition. If the central lesion has reached a stationary point, the aim is then to improve the hemiplegia as much as possible.

TREATMENT.

119. The medical management of the chronic degeneration or convalescence from apoplexy enjoins usually a quiet life, an equable climate, courses of kali iodid, tonics, laxatives if needed, strychnin in small doses, active kidneys, and lower arterial tension. Other measures are lukewarm baths, massage, and galvanic and faradic currents to the affected limbs. When the muscles are atrophied and cold, the most nutritional method of employing static electricity locally on an arm or leg is by means of the rapidly interrupted Leyden jar bath, using always the smallest jars, in 10-minute séances three or four times a week. Sparks have minor uses on the better-nourished muscles only, and as a rule hurt and torment those patients, who are often oversusceptible to pain. When coldness is corrected and muscle-contracting methods are indicated, the Leyden jar current may be used with slow contractions by the usual faradic method. For the general state of debility and lack of nerve-tone, there is practically no equal to potential alternation, to which a spinal and head-breeze may be added when desired. It can also be used locally on the muscles.

These practical measures alone do away with much that is usually recommended. Electricity will do more for these cases directly than most physicians think.

ANTERIOR POLIOMYELITIS.

120. Nature.—Anterior poliomyelitis is the disease of the spinal cord that produces the acute motor paralysis with atrophy now commonly designated as spinal paralysis of children, although it occurs (though rarely) in adults. As static electricity has nothing to do with the acute spinal lesion, our consideration of the subject properly begins with the treatment of the paralysis. In the cord an acute exudative inflammation has taken place, without suppuration. The prognosis under the best treatment depends on the extent to which cell-groups are destroyed and connective tissue (sclerosis) takes their place. To a great extent the degree of atrophy and loss of faradic and galvanic excitability measure the prognosis, together with the lapse of time since the attack. The usual course of the disease is represented by a period of a few weeks during which the paralysis remains stationary after its sudden invasion and maximum height; then a period of gradual improvement for a few months or a year; and after that the permanent chronic state, unless treatment improves it. The legs (one or both) are most often left paralyzed. The muscles are soft, flabby, cold, with minus but sensitive reflexes, and the skin shows trophic changes, being (especially in winter) reddish, dark, and mottled. The long bones may suffer arrest of growth. The foot-deformities depend on the muscles most paralyzed, and may be talipes equinus, valgus, or varus. The anterior tibial, peroniæ, deltoid, and shoulder muscles are most often affected.

121. Prognosis.—This disease does not affect life, and is not progressive; most cases to some extent spontaneously improve, and can be greatly improved by persistent treatment; but few entirely recover when marked loss of galvanic reaction occurs. Orthopedic surgeons retain the care of these patients year after year in severe cases, often during the remaining

growing period of the child, and it is but fair to say that even after 5 or 8 years of almost no improvement under faithful but inadequate treatment, the case is not hopeless, and properly skilled electrotherapeutics may still do much. The general health of the child may be either good or made so under ordinary medical prescribing; but for chronic infantile paralysis, nothing is expected locally from drugs.

TREATMENT.

122. Neurologists teach that electricity is the most important therapeutic measure to be employed, but their textbooks scarcely teach how to use it adequately. The following extract is representative of an otherwise excellent authority:

"At the end of 2 weeks (after the outset), electrical applications may be very cautiously made to the limbs three times a week, if there is no tenderness or fever. After 4 weeks, electrical treatment should be given daily for a month, each limb being treated for only 2 or 3 minutes. After a rest of a fortnight another 4 weeks' treatment may be given. Treatment should thus be applied intermittently until the end of a year. After this it can be continued or stopped according to the condition of the patient. In old cases, daily treatment for 1 or 2 years will sometimes produce valuable results. That form of electricity which causes muscular contractions most easily should be employed, and this is usually the galvanic current."

123. These teachings fail to mention static electricity, which supplements the currents commonly employed, and has three important functions in the treatment of these cases.

1. Mild static sparks, skilfully managed so as not to annoy these little patients, support the tone of adjacent muscles and benefit the general health in cachectic states.

2. During the important period of nerve-degeneration and muscle-wasting, the Leyden jar bath is of great value in nourishing the muscles and preventing the arrest of bone growth.

3. After the cord-lesion becomes stationary, and, in severe chronic cases, when the muscles have become very feeble, or have lost galvanic reaction, the Leyden jar bath is the best basic

treatment to restore warmth, nutrition, and tonicity to the limb, until improvement establishes renewed contractility. These applications should be made three or four times a week, as regularly as circumstances permit, subject, of course, to the usual interruptions of office-practice, and the summer vacations that children should all have.

Accessory home measures should not be forgotten. The most important are passive and active exercise and warmth. Mild cases with less atrophy, and that have early treatment and respond well to the faradic current, are speedily curable. Old, neglected, and extreme cases tax the skill of the physician and the patience of the parents.

INSANITY.

124. The treatment of **insanity** by static electricity can only be spoken of with reserve. As an adjunct to other measures it may, in a limited variety of cases, form a valuable part of the management of treatment. The chief use of this agent in improving the prognosis is in melancholias, acute and subacute manias, climacteric insanity, and psychoses secondary to curable constitutional diseases. In these and even graver cases, it may also palliate other symptoms apart from direct consideration of the mental state. Degenerative insanities with a recognized unfavorable prognosis offer no field for static electricity, except possibly for limited indications.

The etiology, pathology, and therapeutics of the insanities belong to special treatises rather than to a general discussion of static elecricity. It is sufficient to remind the physician that in any morbid mental state in which there is any hope of a favorable prognosis, the patient is not done full justice unless static electricity, properly and regularly employed, is added to the therapeutics. The technique must be adapted both to the indications and to the notions of the patient. Simple positive electrification has an acceptable tonic and quieting action that makes it useful, and a case of violent acute mania has been known to sit an hour on the static platform without restraint during a first treatment, and shortly afterwards sleep

3 hours. Sedative head-breeze, sedative or counter-irritant sprays on the spine, and, when indicated and accepted agreeably, tonic sparks, have all been employed in reported cases. The value of potential alternation as a general alternative and nutritional tonic should not be forgotten.

CURABLE NEUROSES DIRECTLY AMENABLE TO STATIC ELECTRICITY.

HYSTERIA.

125. Causes.—Hysteria is a chronic functional psychosis of unascertained pathology, and is characterized by a morbid susceptibility to mental emotions without will-power sufficient to control them. It also involves sympathetic nervous phenomena. There is frequently a relation between hysteria and derangements of the sexual organs. Violent mental phenomena arising from grief, disappointment, anger, fright, suspense, fear, and disease are etiological factors. A neurotic heredity is common. Many excuses and explanations have been advanced, but definite causes for hysteria are uncertain. Hysteria minor is an aggravated neurasthenia with the psychical state added. It chiefly belongs to childhood and early womanhood. Hysteria major expresses itself in the anomalies of sensation, the paralyses, tremors, contractures, convulsive phenomena, and vagaries of mind that give this disease its unenviable fame.

TREATMENT.

126. The treatment of the hysterical temperament, exaggerated nervousness, and hysteria minor requires chiefly two things: the removal of any source of reflex irritation, if one can be found, and skill in the use of static electricity. Students are cautioned against the common idea in text-books on neurology, that sparks are the alpha and omega of its uses. Minor hysterical manifestations should be gently removed and the functional state coaxed back to normal by sedative-tonic methods of employing the spray, by mild counter-irritant frictions to the spine, and by the alterative-tonic properties of potential alternation. The spark should be

used in a mild form only, and should meet some special indication during the course of treatment. By applying a spark to the local seat of a hysterical pain or disorder of sensation, a reflex stimulus goes back to the center, and should be employed when it is found to be good.

127. In the treatment of true hysteria major, the physician should study the management of the patient as well as the therapeutics of the case. Hydropathy, massage, exercise, and the rest-cure have their advocates. Isolation from friends and family is a common recommendation. Time-tried and approved drugs are few, and their power for definite good is often limited. Nerve-sedatives are the basis of drug therapeutics. Either in addition to any of these measures, or alone and without them, static electricity can be made the most efficient remedy. If, as in rare cases, a central lesion exists, the prognosis is less favorable and may be bad, but in ordinary hysteria the skilled use of static electricity affords a good prognosis.

The tendency to cry without cause is removed by the sedative-tonic head-breeze. Neuralgic crises may be treated by judicious selection of the spray or spark, and nausea is relieved by a warm spray over the solar plexus. The hysterical globus will disappear with many other minor symptoms after counter-irritant frictions on the spine, or a few mild sparks may be added to the region of the larynx. Clavus is relieved by a negative breeze. Local anesthesias respond to needle-sparks. For visual disturbances apply counter-irritant frictions on the cervical spine and ciliospinal center. The paralyses and motor affections of hysteria require local sparks and sparks to the spinal centers. Vasomotor symptoms require no special attention nor do many of the fugitive neuroses. Treat the central nervous system mainly. Correct anemia, and regulate the diet and habits as far as possible. The benefits of static treatment will speedily enlist the cooperation of the patient. Seizures that take the form of trance, lethargy, and catalepsy do not require consideration here, as only the cases that come to the physician's office can receive static treatment.

CHOREA.

128. **Chorea** of the ordinary common form is a subacute or chronic disease with one distinguishing manifestation—irregular and incoordinate movements. It is said to form about one-fifth of the nervous diseases of children, and occurs in varying degrees of severity, from very mild cases to those that (rarely) terminate fatally. Chronic chorea in adults is much less frequent, but is an exceedingly unfortunate state. The pathology of chorea in acute cases is "an intense hyperemia, with dilatation of vessels, minute hemorrhages and spots of softening, the seat of the lesions being the gray matter of the cortex and its meninges, the pyramidal tract, basal ganglia, and the spinal cord." In chronic cases the vascular irritation is less, but there is an increase of connective tissue, and the process resembles a low grade of inflammation. This irritative pathology and its seat points to the treatment by static electricity, which has been successfully employed in many cases. The choreal extremities or muscles are not treated, but a sedative anticongestive spray should be applied to the head and spine.

129. In older cases counter-irritation to the spine is beneficial. Anemia and malnutrition underlie most cases, and this fact is a special indication for general tonic and nutritional methods. Of these, the one described in *Technique and Physiology of Static and Other High-Frequency Currents* as potential alternation is of value, and is agreeable to either children or adults. The well-known exciting causes—fright, injury, mental worry, rheumatism, reflex irritations—also indicate the usefulness of static electricity, as will be better appreciated after a study of its physiological action.

The usual factors in treatment, viz., rest, hygiene, arsenic, hypophosphites, nerve-sedatives, etc., need not be neglected, and static electricity will not interfere with any of them. It is usually important to regulate the bowels. In very chronic chorea in adults, palliation is often all that can be accomplished, but in recent cases that linger under the usual medical treatment, static electricity will hasten recovery.

SPINAL IRRITATION.

130. Well-marked cases of **spinal irritation** were formerly referred to as anemias or hyperemias, but no description is needed here. A standard authority states, "These patients generally get well in from 1 to 3 years, but occasionally they sink into permanent invalidism." Apply moderate counter-irritant frictions to the spine for 2 or 3 minutes, and follow with a sedative-tonic spray to the spine and head. Cases are relieved at once, and often require but one or two treatments, at long intervals, as occasion arises. The Leyden jar current by the labile-faradization method may be still more sedative, but requires disrobing. Prompt recovery is the rule in cases of spinal irritation properly treated with electricity. Local symptoms may need attention, and static applications can readily be adapted to them. Localized potential alternation upon an affected area is very effective. Spinal irritation is so rapidly and easily corrected by the simple resources of electrotherapeutics that any other remedy is rarely needed.

NEURASTHENIA.

131. Introduction.—The prevalence of **neurasthenia,** the frequency with which it is passed over unrecognized, the rich harvest it offers to unprincipled persons that trade on the ignorance, weakness, and frailty of humanity, make it incumbent on the general practitioner to inform himself on every detail of its pathogeny, clinical course, and therapy. In 1879, Beard gave the name of neurasthenia to a diseased condition that had been previously described under various denominations. Regarding neurasthenia in its entirety, one of its most striking features is the multiplicity of aspects in which it exhibits itself, depending on individual constitutions. It is thought proper to state here that a good many nervous disorders are chronic and resist all treatment, and that unfortunately this notion prevails in regard to all nervous disorders. While a good many nervous disorders are chronic and resist treatment, the larger number of nervous diseases met with in private and hospital practice are functional in their nature, and

these either tend toward spontaneous recovery or yield to appropriate treatment. Among the nervous diseases tending to spontaneous recovery or yielding to appropriate treatment the following may be cited: neurasthenia, paroxysmal neuroses, hysterical affections, various forms of neuritis, and neuralgia. Even organic diseases of the nervous system are not so fatal as organic diseases of the heart, liver, kidneys, and lungs, and are frequently more amenable to palliative treatment.

132. It has been already stated that one of the most striking features of neurasthenia is the multiplicity of the aspects in which it presents itself. Another feature equally striking, though of a negative character, is the absence of physical signs. The symptoms are, for the most part, subjective. The patient recounts his feelings, and the physician interprets his patient's history through his knowledge of anatomy, physiology, pathology, and clinical medicine. Among the striking features of neurasthenia, particularly among those generally observed, nervousness holds a prominent place. The majority of neurasthenic patients on their first visit to a physician complain of feeling nervous. This feeling of nervousness is particularly significant of neurasthenia when it occurs in a strong-minded man that has previously been in good health.

133. Types of Neurasthenia.—There are three clinical types of neurasthenia—the *cerebral*, the *spinal*, and the *cerebrospinal*. Pure spinal neurasthenia without cerebral symptoms is extremely rare. Symptoms referable to the spinal cord often predominate in the history of neurasthenia, but they are accompanied by cerebral symptoms more or less accentuated. Whether neurasthenia is of the cerebral type or of the spinal type or of the cerebrospinal type, it is always accompanied by symptoms produced by disturbance of the vasomotor and sympathetic systems.

134. Neurasthenia is usually defined as a neurosis without an organic basis. According to Savill, neurasthenia is an irritable weakness of the entire nervous system, characterized by hypersensitiveness of the tactile sensibility and special

senses. When neurasthenia is of the cerebral type, it is characterized by headache, inaptitude for mental work, disturbed sleep, and irritability of temper; and when it is of the spinal type, there is general weakness, restlessness, nervousness, and vague pains. The symptoms present in any given case will depend on the clinical type and on the special idiosyncrasies of the patient.

135. Etiology.—The etiology of neurasthenia depends more on the individual than on anything else. Neurasthenia is most common between the ages of twenty and fifty, and is encountered in about equal frequency in men and women. The part played by heredity in the etiology of neurasthenia is recognized by all. It manifests itself in an instability of the nervous system, and a liability to other nervous diseases. Indoor life is a very important predisposing cause of neurasthenia. Whether the work of the individual is physical or mental, if performed indoors, the tendency to neurasthenia is liable to be established. Masturbation is another predisposing cause that should always be borne in mind; in fact, when no other cause can be ascertained, masturbation, alcoholism, or the morphin-habit should be suspected. Among the exciting causes of neurasthenia, overwork, great grief, traumatism, asthenopia, and the excessive use of certain drugs may be cited. Any of these causes overtax the nervous system and produce exhaustion.

136. By disturbing nutrition, dyspepsia, chronic constipation, and malnutrition, due to insufficient or improper food, become exciting causes of neurasthenia. The malnutrition may be due to exhausting diseases, influenza, diphtheria, typhoid fever, phthisis, or constitutional debility from any cause. It is only within recent years that traumatism has been recognized as an exciting cause of neurasthenia; and it is in this relation that traumatism has within recent years gained considerable medicolegal importance. The neurasthenic symptoms may develop immediately after the injury, or it may be weeks or months before their presence is made known. The type of neurasthenia following injury in the aged is always

extremely grave. It is not the traumatism itself that produces this neurasthenia, but the shock or sudden strain of nerve-cells.

137. Pathology.—The pathology of neurasthenia is based entirely on analogy. There is no recorded case of death from neurasthenia attended with an autopsy. Neurasthenia has been defined as a disease of the railroad, telegraph, and telephone life of our modern civilization. The recent investigations of Hodge, demonstrating changes in the nerve-cells during functional activity, may throw some light on the pathology of neurasthenia. The pathology of neurasthenia may be studied in the known pathology of those diseases that resemble it clinically. It is conceded by all at the present time that neurasthenia is a pathological condition—a legitimate morbid entity. In studying its numerous symptoms, the greater portion may be readily referred to the neuromuscular system, and the remainder to the vasomotor and sympathetic system. All the symptoms are those of an irritable and weakened nervous system; there is general instability combined with lack of endurance.

138. According to Savill, neurasthenia may arise under four different pathological conditions: (1) toxemia, or toxic blood states; (2) malnutrition of the nervous system; (3) overfunctioning the nervous system (fatigue neurasthenia); (4) emotional shock and traumatism. Whether or not these different pathological conditions produce neurasthenia will depend on the endurance and neural energy of the individual. An inherited weakness of the nervous system is the most common predisposing cause. The children of neurotic, alcoholic, or tubercular parents are very prone to develop neurasthenia when attacked by any of the pathological conditions already mentioned. General malnutrition is alone incapable of producing neurasthenia; but when it is accompanied by overwork or strain, physical or mental, the phenomena of neurasthenia are likely to develop. Malnutrition, as a predisposing cause of neurasthenia, acts like an inherited weakness of the general nervous system. The neurasthenia that follows influenza is due to general malnutrition, and to the toxic effects of

influenza on the nervous system. Fatigue neurasthenia is the type most frequently met with among the better classes of life. It is the neurasthenia of the physician, of the lawyer, financier, and merchant. Traumatic neurasthenia is perhaps less frequently encountered than the other varieties.

139. There are two important factors in every case of neurasthenia; namely, the pathological condition that underlies the disease, and the constitutional type of the patient. An individual with a robust and vigorous nervous system will eliminate toxic materials from the blood without exhibiting any of the phenomena of neurasthenia; whereas one with a neurotic taint, or the victim of bad hygiene, or of insufficient and improper food, will almost surely suffer from some form of neurasthenia.

140. Symptoms.—Headache is the most constant symptom of neurasthenia. It is generally located in the forehead or occiput, and is often compared to the pressure of a band around the head (the *casque neurasthenique* of Charcot). Rachialgia is another prominent symptom. Sometimes it exists alone, and may be limited to the coccyx or sacrum. Mental depression is almost never absent. Depression seems inherent in neurasthenia. The neurasthenic has lost the faculty to concentrate his attention, and his will-power is considerably weakened. He is easily fatigued, easily discouraged, and always tired, even on rising in the morning. His memory is poor, particularly his memory for proper names. He is uncertain both in what he says and in what he does. A feeling of insecurity in speech and action is very characteristic of neurasthenics.

141. Inaptitude for mental work and lack of will-power, like the other symptoms of neurasthenia, change from day to day. The neurasthenic patient is irritable and easily annoyed. There may be agoraphobia (fear of open space) or claustrophobia (fear of closed space). Though there is a feeling of general weakness, the patient is restless and desires to be constantly moving. He wants to be in some other place, not where he is. He wants some other occupation, not the one he

has. Insomnia is a common symptom in neurasthenia, and while it exists there cannot be much improvement in the patient's condition. To the exhausted nervous system, sleep is the most perfect form of rest. Some patients have difficulty in getting asleep; some awake after a few hours' slumber and remain so until daylight. During business-hours a neurasthenic may have difficulty in keeping awake, and may find it necessary to take a narcotic to procure sleep at night. The most frequent form of disturbed sleep differs considerably from true insomnia. The patient falls asleep easily—indeed, feels drowsy and depressed most of the time—but his sleep is not restful. He awakes in the morning more tired and exhausted than when he retired at night. The so-called "night terrors" frequently accompany the sleep of neurasthenic patients. Delusions and hallucinations are transient, and vary from day to day.

142. The symptoms referable to the vasomotor and sympathetic systems are, flushings, palpitation, pallor, shivering, sweating, cold hands, and feet. The *tache cerebrale* of Trousseau can often be produced. The patient complains of various sensations, such as the crawling of insects beneath the skin. The pulse is usually rapid and weak, and its chief feature is its excitability. The least surprise or excitement causes the pulse to beat rapidly and sometimes irregularly. It is a pulse of low tension. The patient frequently complains of dizziness and vertigo, which may amount to actual syncope. All these sympathetic symptoms are under the control of and produced by the vasomotor system of nerves.

The gastro-enteric symptoms are of two kinds: those due to purely nervous causes, and the ordinary symptoms of dyspepsia. The purely nervous gastro-enteric symptoms, like the other symptoms of neurasthenia, are irregular and vary from day to day.

It will be observed that all the symptoms thus far enumerated are purely subjective; they are related by the patient to be interpreted by the physician. There are two objective symptoms of neurasthenia that, on account of their importance,

should always be remembered. They are the exaggerated knee-jerk and the retraction of the fields of vision

Asthenopia is a symptom of neurasthenia, and is of great diagnostic value. It is due as a rule to defective equilibrium in the muscles that control the movements of the eyeballs. Asthenopia produces a sense of weariness when the eyes are steadily employed for short periods of time.

143. Diagnosis. The presence of the cardinal symptoms of neurasthenia, headache, nervousness, intellectual and bodily enfeeblement, various vague sensations, exaggerated knee-jerks, retractions of the fields of vision, and the absence of any other physical signs, enable one to arrive at a diagnosis. Hysteria is the principal disease with which neurasthenia is confounded. Neurasthenia is characterized by exhaustion, and hysteria by perversion of functions, local paralysis, and anesthesia. Hemianesthesia is rare in neurasthenia, and hyperesthesia is common enough. Hysteria is more common in females, neurasthenia is equally common in both sexes. In hysteria the emotions predominate, in neurasthenia intellectual weakness leads. In neurasthenia there is a decided inaptitude for mental work; whereas, hysterical patients, when the hysterical crisis is past, delight in intellectual work.

144. When neurasthenia has existed for months or years, hypochondriasis is usually an important symptom. When the nervous and circulatory symptoms of Graves's disease precede the enlargement of the thyroid gland and the exophthalmus, there is real difficulty in distinguishing it from true neurasthenia.

The diagnosis between a marked case of cerebral neurasthenia and true insanity will always require serious study of every detail of the case, for it must be remembered that when there is an hereditary tendency to insanity the prodromal period is usually constituted by neurasthenia.

145. Course and Prognosis. With the exception of traumatic cases, neurasthenia is generally gradual in its onset. Its course, when not modified by treatment, extends over months and years—now better, now worse. If treatment is discontinued while improvement is taking place, and before the

return of health is complete, there is a marked tendency to relapse. In neurasthenia there is no danger to life, but this does not make the treatment less urgent, because the sufferings of the patients are severe. The chief unfavorable symptoms are melancholia and retraction of the fields of vision. When these two symptoms are present, the disease is likely to be intractable. The prognosis will depend on the age of the patient, on the time during which he has suffered, on his individual constitution, and on the pathological condition that underlies the disease. In the aged, neurasthenia runs a prolonged, intractable, and sometimes fatal course. In the young, when the cause is removable, the prognosis is extremely good. It may be stated that, if the cause of neurasthenia is removable, there is no nervous disease more amenable to treatment.

TREATMENT.

146. If eye defects exist, they should be corrected by appropriate means. The most important factor in neurasthenia is the pathological condition that underlies the disease, and the most important consideration in treatment is the removal of that condition. The treatment par excellence of neurasthenia is static electricity. Various methods of treatment are pursued with more or less success. Among which may be mentioned: absolute repose, isolation, massage, hydrotherapy, with the conjoint use of iron, the bromids, chlorid of gold and sodium, and laxatives. On account of its simplicity and efficacy, these have all been superseded by static electricity.

147. It is possible in this disease to get well. No case need despair. Standard works on neurology teach that the measure of leading importance in the treatment of neurasthenia is rest, and they state that the elaborate rest-cure is "undoubtedly the best for many cases." We cannot agree with this classical teaching, nor with the teaching that "hydrotherapy offers the chief extra-drug remedy." Apart from the fundamental principle of regulating personal hygiene and diet, and prescribing any major drugs for which specific indications exist (as iron

in anemia), the rapid improvement of neurasthenic patients may be almost invariably brought about by the resources of electrotherapeutics. The galvanic and faradic currents have certain uses, but many cases have been restored to comfort in from 2 to 3 months by static electricity alone, without either drugs or rest or any change of work, habits, or mode of living. In private practice it is best to use every rational means that will hasten the improvement of the patient.

The chief general nutritional and sedative-tonic remedy is potential alternation. Other methods to employ will be localization of the breeze and spray, or occasionally counter-irritant spinal frictions, according to indications presented. Sparks have a very subordinate place in the treatment of neurasthenics, and are often badly tolerated by them, but when they are required they should be used with studied skill to avoid unpleasant irritation. Unscientific methods of using static electricity are to blame for most of its failures, and it is the object of this Course to spread far and wide among the medical profession a recognition of proper methods, hitherto almost neglected.

HEADACHE.

148. This most frequent of nervous symptoms is an attack of diffuse pain affecting different parts of the head, but not confined to a particular nerve. It is the result usually of peripheral irritations reflected within the skull. The causes are not only legion, but the same person may have at different times different kinds of **headache.**

TREATMENT.

149. Seek the cause always as a starting-point to definite prescribing. If the etiology of the headache involves any disease—local or constitutional—of which the treatment by static electricity is taught in this Section, it should be employed accordingly, by the methods described. Palliative or curative applications to the seat of pain are chiefly modifications of the breeze or spray. Frontal headaches (including temples)

are often relieved by the negative breeze applied with the electrode about 2 inches from the surface. Aches of the vertex and occiput are most often treated by the positive breeze. In many cases a moment's sharp counter-irritation at the nape of the neck is effective. Many mild headaches disappear during a séance of potential alternation. Some headaches not entirely relieved by any form of static treatment cease before the patient gets home. The headaches that will not be reached by static electricity are those dependent on active continuing causes, unless these causes are removed. The common forms of chronic and recurring headaches are anemic, dyspeptic, and neurasthenic, but the least amenable to static electricity is the bilious headache. Other remedies are required for all headaches arising from disordered digestion, chronic diseases of the uterus, and eye-strain.

MEGRIM.

150. Causes.—**Megrim** is differentiated from the headaches by medical writers, and is not a neuralgia. It is described as a constitution neurosis, with periodical paroxysms of pain affecting chiefly the fifth nerve. It is usually a hemicrania, and is popularly called a "sick headache." Associated with it are nausea or vomiting, mental depression, pallor of the face, and disturbances of the eye and ear of the affected side. All these symptoms point to disturbances of the vasomotor system. It occurs in neurotic patients, oftener women than men, and anemia and depraved nutrition are prominent complications. It is a disease of the prime of life. The first attack rarely occurs after the twenty-fifth year. There is no anatomical lesion known, but uric acid is a suspected cause. An eye-strain or defect is always to be sought for.

151. Prognosis.—Under the usual drug palliatives or anodynes, "the prognosis for a radical cure is not good." Thorough constitutional treatment, and the removal of reflex irritants, if they exist, should cure most cases in 3 or 4 months. Drug-habits (morphin, etc.) should be guarded against.

TREATMENT.

152. Exclude or correct eye and nasal deficiencies or deformities. Prescribe for the anemia, aid digestion and nutrition, palliate the attacks as each case demands, and between attacks rely with confidence on the curative action of regular and persistent static administrations. Aim at constitutional nutritional improvement. Potential alternation is agreeable and efficient, while sparks, as commonly abused, are dreaded by nervous women. The abuse of static sparks is always a sign of lack of knowledge of the proper uses of this great therapeutic agent. Sedative-tonic sprays on the spine and head, also brief counter-irritant frictions at the nape of the neck, are beneficial local applications. With the progress of treatment the attacks will become less severe and less frequent, and as the general state of the patient is restored to vigorous, well-nourished nervous stamina, the megrim ceases gradually. An unfavorable environment may retard or prevent this result.

INSOMNIA.

153. **Etiology.**—The treatment of **insomnia**, in order to be successful, must be preceded by a careful investigation into the cause, and by a thorough knowledge of the modification of the function of sleep in each particular case. The importance of ascertaining the cause is self-evident, for on its amenability to treatment the prognosis of the case depends. Some victims of insomnia go to sleep immediately on retiring, but awake in an hour or two and remain awake for the remainder of the night. Two hours' sleep does not suffice for complete recuperation, and a diminished capacity for work the next day is a necessary consequence. This type of insomnia is usually caused by arteriocapillary fibrosis, and insomnia is but one symptom of the morbid process. Other patients have great difficulty in getting to sleep. They exhaust themselves as much in their efforts to procure sleep as they do in fulfilling the duties connected with their calling during the day. The sleep that they finally obtain is normal in quality, but the quantity does not suffice, due to the necessity of rising at a

certain hour to resume the occupations of the day. This type of insomnia is usually due to mental overwork.

154. Brain-Workers.—Brain-workers are particularly liable to insomnia, as the cerebral cells are apt to remain active after work has been abandoned. The ambition to finish an alloted task, or the habit of trying to get 2 days' work into one, is responsible for the perversion of many cerebral functions—sleep in particular. The practice, common among ambitious brain-workers, of trying to make every 24 hours count as much as possible, by contracting the hours of sleep, either in staying up late into the night or in rising at too early an hour in the morning, cannot be too vigorously discouraged.

155. The insomnia of infectious intoxications, and of hetero- or auto-intoxications, is characterized by drowsiness and restless sleep. These patients complain of disturbed sleep, fatiguing dreams, and night terrors. This type of insomnia is frequently encountered in gastro-enteric disorders, and particularly in alcoholics. Some sufferers from insomnia sleep, apparently soundly, for 8 or 9 hours, yet they awake feeling depressed and fatigued. There are two important factors in sleep; namely, its quantity, and its quality. It is a well-known fact that a siesta of but a few minutes is often followed by a feeling of activity and a desire to work, whereas a long and apparently profound sleep may be followed by lassitude and depression.

156. Classification. — The classification of insomnia according to its cause is the most practical. The following classification is that adopted by Dr. Joseph Collins: (1) Insomnia due to exalted states of the sensory sphere. Pain is the best example of causation in this class. It includes paresthesia of every kind. (2) Insomnia due to psychic causes, such as grief, fear, worry, mental depression or exaltation, neurasthenia, hypochondria. (3) Insomnia due to toxemia or toxic states of the blood. To this class belong the insomnia of acute infectious and contagious diseases, and also that due to alcohol, tea, coffee, tobacco, and drugs. The insomnia of gastro-enteric diseases, of rheumatism, gout, and diabetes

belongs to this group. (4) Insomnia due to organic diseases. Insomnia may be a symptom of any organic disease, but it is particularly important as a symptom of general arteriocapillary fibrosis. No matter what the pathological condition underlying the insomnia may be, the cerebral cell is in a state of vigilance when it ought to be in a condition of repose.

157. Pathology.—Insomnia is not a disease, but a symptom, and a symptom that is frequently present in a multiplicity of diseases. It may be a very troublesome symptom, associated with an affection of no importance in itself, or it may be an almost negligible symptom, associated with an organic malady of a rapid and fatal course. The diseases in which insomnia is most frequently encountered differ as widely in their nature as they do in their gravity. The condition of sleeplessness is as much influenced by the state of the nervous system, whether weak or strong, by the individual idiosyncrasies of the patient, by the presence or absence of a neurotic taint, and by the general physical condition of the patient at the time, as it is by the underlying pathological affection.

158. Another important factor in all cases of insomnia is the perversion of cerebral circulation. Either primarily or secondarily, there is perversion of the circulation, influencing the quality and quantity of blood in the cerebrum and changing its normal rate of flow. The cerebral cell, like the hepatic or renal cell, requires a normal blood-supply for the performance of its physiological functions, and for its recuperation when exhausted. The blood-supply of any organ varies with the work it has to do. The experiments of Mosso demonstrate that mental activity and emotional excitement are accompanied by functional cerebral hyperemia.

TREATMENT.

159. As only the general traits of insomnia are considered in the above description, the treatment will be described in the same general manner. The first indication in the treatment of insomnia is to find the cause and remove it if possible. Hypnotics have been used too freely, and they have, without doubt,

done much harm. It may be stated, however, that sleep procured through drugs is infinitely better than no sleep at all. Hypnotics are of great value in breaking up the habits of sleeplessness, and in contributing to the patient's comfort while other means are being employed to remove the cause of the insomnia and to give tone to the system. With this view of the use of hypnotics, when the cure of insomnia is the end sought, the chosen hypnotic should be given in gradually decreasing doses, and not in gradually increasing doses, as is usually the custom.

160. Hydrotherapeutics occupies an important place among the general agents used to combat insomnia. A prolonged warm bath, to which some pine-needle extract has been added, is very serviceable in insomnia due to mental or physical exhaustion. Massage is another agent of value in selected cases, and may be employed conjointly with hydrotherapeutics. General massage is the most efficacious method if there is no contraindication to its use. Insomnia due to grief, worry, overwork, excitement, or depression is the type most frequently encountered in general practice, and it will require careful study of every detail of the case, and a judicious selection of remedies, general and specific, to overcome the disease. Among the drugs used, sulfonal or trional may be given in from 10- to 30-grain doses. Trional acts more expeditiously, but it has reactional effects. The most reliable hypnotic is chloral hydrate. The knowledge of its dangers should be familiar to every physician prescribing it. Its only absolute contraindication is cardiovascular degeneration, and even here it may be administered with very pleasing results when guarded by a cardiovascular stimulant, such as good brandy or whisky. The derivations of chloral, chloralamide and chloralose, are serviceable remedies. Chloralamide is free from the risk that the patient will form a habit. It may be given in from 15- to 40-grain doses. Chloralose is given in from 5- to 10-grain doses. The next in importance to chloral as a drug remedy in the treatment of insomnia comes paraldehyde. It has a disagreeable odor and is nauseous, but is otherwise an

ideal hypnotic. It is usually given in dram doses, but may be given in much larger doses without danger. It has very little if any depressing effect on the heart when given in moderate doses. When patients have weak, sensitive stomachs, it must be given with caution, on account of the disgestive troubles it is likely to produce. In arteriocapillary fibrosis, the greatest caution must be exercised in prescribing hypnotics, and it is a good rule to always combine them with some cardiovascular stimulant.

161. Static Treatment.—Many functional (especially nervous) causes of partial insomnia, imperfect, and unresting sleep disappear during the ordinary course of treatment with static electricity, regardless of the major condition for which the patient sought advice. Dyspepsia, even when unrecognized, is a cause of insomnia in some persons that wake at one, two, or three o'clock in the morning and cannot sleep again till just about time to get up. This form of derangement is not best treated with static electricity. But chronic functional disturbances of sleep, associated with any other disease that static electricity ameliorates or cures, will be improved by this agent. Direct treatment limited solely to an application for insomnia alone will rarely require the attention of the physician. In such a case, however, he may choose between simple positive electrification, potential alternation, and sedative breeze on the head and spine. Whatever improves the general functions will generally improve the function of sleep, and in this respect static electricity is, in a great variety of cases, one of the most valuable remedies.

SCIATICA.

162. Cases of pain in the course of this nerve will all be considered here, whether due to neuritis, rheumatism, or neuralgia. Pains from pressure or disease within the pelvis are excluded, as they obviously require removal of the mechanical cause. The treatment of **sciatica** by drugs and by electricity is to be viewed from quite different standpoints. The indications for curative drugs may be obscure and results doubtful. The indications for the use of static electricity are

for the most part definite, and its proper employment unites curative effects with immediate palliation. Apply the sedative spray, followed by thick obtundent sparks, to any painful points that are tender to pressure. Muscles that are simply stiff, or painful on movement, with a tendency to coldness, may be warmed and relaxed by counter-irritant frictions, followed by mild sparks and hot spray. If pains are of a shifting neuralgic type, apply a counter-irritant spray to the spinal origin of the affected nerves and to any point in the distribution in which sensitiveness can be detected. If the pain is localized in fixed places, posture to cause an aggravation and apply single percussive sparks until relieved. Failure to give rapid relief points to an error in diagnosis. Cases of interstitial neuritis are among the most difficult to conquer. Counter-irritation methods of utilizing the static current are indicated in various degrees. Besides sparks, the Leyden jar current or local potential alternation can be employed.

NEURALGIA.

163. Nature.—The relation of all electric currents to neuralgic pains cannot be too carefully studied by the physician. Neuralgia is essential nerve-pain, excluding all other forms of pain; but the diagnosis between the pains of neuritis and pure neuralgia cannot always be made at once. States of lessened nutritional vigor, functional derangements, local irritations, and constitutional disease, briefly sum up the general causes of neuralgia, and also constitute a general indication for the tonic, nutritional, and function-regulating action of static electricity, as every student will recognize on reading its physiological actions. The shifting, paroxysmal pains in the course of the nerve, and exclusion of other diseases, make the usual diagnosis.

164. Prognosis.—The prognosis under medical treatment is better in books than average patients find it. Cases with neurotic heredity, anemia, and vitiated vitality may suffer for many years. The proper use of electric currents improves the average prognosis incalculably.

TREATMENT.

165. All cases of neuralgia associated with constitutional disease, or even merely a nervous or debilitated state, should be given general tonic and nutritional static treatment—potential alternation, tonic sprays to the spine and head, and stimulating frictions to the spine. A warming anodyne, and eventually rubefacient sprays should be applied locally to the seat of pain when it attacks chiefly a definite part. If pains are shifting, apply the same spray to the course of the nerve to points of tenderness, and to its origin in the spine. Accessory medication may be prescribed for constitutional effects.

When static treatment fails to give the expected relief, it points to an unsuspected lesion as a cause of the pain, as purely functional pains quickly respond to the spray or the spark. A skilled operator will in later séances usually follow the spray with a judicious use of mild sparks. Sparks produce the instantaneous and deep-acting counter-irritation for which other measures have been suggested hypodermically or by puncture. The superiority of electricity over any or all extra-drug measures in the treatment of neuralgias will be better appreciated the more it is used and studied.

WRITERS' CRAMP, ETC.

166. Cause and Nature.—Writers' cramp, operators' paralysis, the lame arms of ball-players, professional pianists, and other occupations all belong to the same group of affections. They merit the study of the physician, owing to the large number of persons they afflict, it being estimated that in the United States alone over 30,000 telegraphers have some degree of operators' palsy. Prominent neurologists have taught that "writers' cramp is a chronic functional neurosis characterized by spasmodic, tremulous, incoordinate, or paralytic disturbance when the act of writing is attempted, and associated with feelings of fatigue and pain."

Of the morbid anatomy it is commonly said that three chief theories are held regarding its nature: (1) a local disease; (2) weakness in certain muscles, permitting overaction on the

part of their antagonists, and increasing spasm; (3) a central lesion. Careful authorities have collected many theories and symptoms and accounts of writers' cramp; but one that has had the disease himself cannot attach serious importance to much of the classical literature. Still less can one that successfully treats all uncomplicated cases endorse the classical directions regarding rest, mechanical devices, prophylactic precautions, and empirical therapeutics, nor accept the verdict that the prognosis is unfavorable.

Writers' cramp (including operators' paralysis and all forms of the disease) is a gradual exhaustion of nerve and muscle tonicity with chronic peripheral degeneration of nutrition, the result of presistent work in excess of the capacity of the muscle-fibers to fully regenerate themselves by rest. The teachings of Dr. S. H. Monell, in his monograph entitled, "The Cure of Writers' Cramp and the Arm-Troubles of Telegraphers and Ball-Players," are followed in this Section, and clinical experience bears out the correctness of his views. Every case is curable under favorable conditions unless some disabling complication exists, and in many cases complications only delay the cure, for they may be removed by patient treatment, or improved so that they no longer amount to a disability.

TREATMENT.

167. Drugs are of little direct service in the treatment of writers' cramp. If rest were curative, there would be no chronic cases, since all that become disabled are obliged to rest when they can no longer work. It is safe to say that no case is cured by rest. Successful treatment along definite and effective lines requires two things: (1) a knowledge of the peculiarities of affected arms; (2) an expert skill in electrotherapeutics. The first of these the physician must acquire by clinical experience with actual cases. After (and not before) he has become skilled in the uses of all three currents, he can acquire the proper technique. For 70 or more years the disease has been all but incurable. The technique taught by Doctor Monell after 5 years of study and experimental applications renders early

cases among the most satisfactory in office-practice, and changes the prognosis to positively good. While included here among neuroses on account of the classification of standard textbooks, this condition is not properly a neurosis, but is a muscular lesion that forms a class by itself.

168. 1. General tonic electrification should be employed to build up the general health when this is below par. The most effective tonic method is that devised by Doctor Monell in 1893, and described in his writings as potential alternation.

2. Nutritional sedative-tonic, or, in some cases, counter-irritant applications to the spine should be used as they may be indicated for each patient. Seat the patient on the static platform, connected with the negative or the positive pole, according to the therapeutic needs of the given case; ground the opposite pole and ground the brass-ball electrode to the gas-fixture; start the plates of the machine in moderate action, and make rapid frictions up and down the spine. Then change the electrode to the multiple needle-point and complete the application.

3. Stimulate the circulation in the affected arm to prepare the muscles for nutritional contractions. Apply both frictions and needle-sparks for this purpose.

4. If the trouble is all above the wrist, roll up the sleeve of the affected arm, wind a chain around the region of the biceps, and connect it to the negative pole. Ground the positive pole and the ball electrode, and with the machine in moderate action, with just enough force to act comfortably on the muscles, interrupt the current at a slow rate. Instruct the patient how to adjust the position of the arm during treatment so that effects will be directed on the muscles employed in sending. Then move the chain to the upper half of the forearm and repeat the process. Regulate the dose to produce an invigoration and sense of lightness in the arm. If fatigue is caused, the current has not been properly regulated. Besides this slowly interrupted local form of potential alternation, Dr. Monell uses the same with very rapid tonic interruptions regulated by a spark-gap either between the poles or by an

electrode adjusted near one pole. When employing rapid local potential alternation, the muscles are to be quickened by a few slow contractions at the end.

5. Prepare a water-bath electrode if the trouble extends into the wrist and hand. Connect it with the negative pole, and immerse the affected hand to the wrist. With the brass-ball electrode, produce mild nutritional contractions of the affected muscles, directing the effect on each group by shifting the position of the arm as required. Regulate the dose according to the action desired, and moderate it to the lowest point while treating the finger-muscles. Close the application with a few sharp sparks upon the large muscles of the upper arm and the roots of the brachial plexus. Perfect comfort and endurance must be maintained by correct dose regulation, for if tolerance is exceeded, the effect will be injurious instead of nutritional.

6. Rest and refresh the whole arm by a counter-irritant static spray. If the arm has felt as if it would drop off before the séance, it should be made as light and as energetic as the good arm before closing this part of the treatment. Direct a sedative spray, also, to the relief of any pain that exists, or sore feeling on the under side of the forearm or on the back of the hand or wrist. Also remove the sense of weight so commonly felt on the back of the wrist. If complications, such as rheumatism, lumbago, neurasthenia, or minor symptomatic disturbances, exist, treat them at this time.

SPECIAL PARALYTIC LESIONS.

PARALYSIS AS A SYMPTOM.

169. Cause.—In considering the relation of static electricity to paralyses of all kinds, the physician should recall the two pathological facts that destroyed motor cells will not respond to electrical stimulation and that the integrity of the nerve-path is essential to a cure. Paralyses are variously classified, but they are all either motor or sensory, and of cerebral or spinal or peripheral origin. To treat of each kind with regard to pathology, etiology, and symptomatology would fill many

pages with repetition familiar to every physician, and would be the more useless from the fact that static electricity can only be employed along certain lines of procedure that are alike in all cases, whether the paralysis is due to embolus, hemorrhage, traumatism, irritation, hysteria, lead, diphtheria, cold, a tumor, or any other cause; and if the lesion and the paralysis are of a nature outside the physiological action of static electricity, this agent will not cure it. Therefore first study those actions, as taught in *Technique and Physiology of Static and Other High-Frequency Currents.*

170. Some Important Considerations.—There are five questions to ask in the therapeutic consideration of any case of paralysis with reference to static electricity, regardless of the cause.

1. Is the part affected one that can be conveniently reached by this somewhat unwieldly form of current?

2. Do the muscles react to static sparks or to a Leyden jar current? If so, they may be locally employed; if otherwise, they cannot be so used with much benefit.

3. Is nutrition impaired so that textural changes have taken place? If so, employ Leyden jar currents by labile electrodes or local bath-method until nutrition is restored as much as possible.

4. Do the nerve-centers require treatment? If so, the spray, spark, or frictions must be selected according to the individual case.

5. Does the general state of the patient require improvement? If so, the manner of treatment is independent of the paralysis and must be regulated by the needs of the case.

Will any form of static application attack the cause of the paralysis, improve the nutrition of the muscle-fibers of the patient, and cause the muscles to contract? Static electricity will attack the cause and improve both the general health and the local paralysis in cases that occur as sequelæ to smallpox, diphtheria, typhoid fever, syphilis, gout, rheumatism, poisoning by lead, mercury, arsenic, phosphorus, hysterical paralysis, paralysis caused by reflex irritations (after they are removed),

cold and damp, acute pressure on a nerve, peripheral injuries, acute physical exhaustion, and cases allied to these.

In the paralyses of central lesions, with atrophy of the muscles, static electricity will improve the general health, remove pains, relieve symptoms, correct neurasthenic debility, improve appetite, digestion, and sleep, if these are impaired, and work a partial improvement in the paralyses, together with return to normal sensation and temperature if the parts were cold. These statements are equally true of infantile paralysis following anterior poliomyelitis. The degree of improvement will vary in different cases, depending partly on the lapse of time since the beginning of the paralysis and on the extent of the lesion.

171. Methods of Static Treatment.—The methods of static treatment for any form of paralysis are as follows:

1. The slowly interrupted Leyden jar current is very efficient in cases of peripheral paralysis that retain faradic excitability.

2. Sparks are efficient in simple cases in which a sensory or circulatory stimulus is desired in addition to muscle-contraction.

3. The rapidly interrupted high-potential Leyden jar current-bath is efficient in combating trophic changes and restoring nutrition, warmth, and contractility in cases in which these are lost to ordinary methods, provided the part can be placed in a local bath.

4. Arm-muscles can be exercised by the method of localized potential alternation, which consists in placing the hand in a jar of water connected with one prime conductor, or winding a chain from the prime conductor around the muscle-masses of the arm and forearm, and causing contractions by sparks on the terminal of the machine; or any ordinary faradic electrode may be employed in the same manner with the interrupted static current, regulating the dosage by the length of spark-gap between the sliding-poles. Doctor Monell has, since 1893, employed these methods in the treatment of writers' and telegraph operators' paralyses. Since 1899, these methods of localized alternating static applications have been advocated by other writers under the name of "wave currents."

It being the cardinal rule in electrotherapeutics to select, for the treatment of a paralyzed muscle, that form of current which on actual trial will induce the most efficient contractions of the affected muscles, the galvanic current supersedes the static in many diseased states. No study of electricity is rational that does not have regard to the actions of all currents used in medical practice. Generally, the treatment of chronic paralytic lesions not only requires the change from one current to another during the course of improvement, but improved and modern apparatus is also essential to the best results. To treat these lesions, as many physicians unfortunately do, with a common hand faradic battery that has little therapeutic value, is a serious evil, and however honestly it may be done, it is, through lack of knowledge, closely allied to the worst quackery.

INJURIES OF PERIPHERAL NERVES, CAUSING PARALYSIS.

172. Characteristics. — Laceration, compression, concussion, tearing, stretching, or any form of traumatism to a mixed nerve, causes more or less change of nutrition, temperature, sensation, and motor functions in the muscles supplied by the injured nerve. The loss of electrocontractility is proportionate to the degree of damage done the nerve-fibers. Both with reference to prognosis and treatment, these cases must be divided into two groups, regardless of the nature of the traumatism: (1) those of recent origin, and (2) those of a chronic character. With the first, which are marked by acute inflammatory or degenerative changes, static electricity may well be employed by sedative methods or counter-irritation when indicated. Localized potential alternation is one of the best forms of treatment in many cases. In chronic cases, we have mainly to deal with trophic changes, pain, and partial or complete paralysis. In simple concussion and compression injuries, atrophy and pain may be absent, but there is usually some disorder of sensation and some impairment of motion. In severe lacerations, the chronic state may involve other muscles than those supplied by the damaged fibers; atrophy may be extreme, and coldness of the part may be as troublesome to the

patient as any symptom, save the paralysis. Since any nerve in the trunk or extremities may be injured by external violence, the physician requires the principles of prognosis and treatment rather than a repetition of anatomical names. Of prime importance are certain demonstrated facts regarding the prognosis.

173. Prognosis.—The repair of motor cells, once lost, is practically impossible, while the conducting nerve-fibers emanating from healthy motor cells possess an almost unlimited power of regeneration. Muscles that are supplied by injured nerve-fibers waste and remain for a long time paralyzed, and may never spontaneously recover, if their electric contractility is lost. They will require long and patient treatment, and the final result may be less than a complete cure. Muscles that retain electrocontractility will rapidly respond to treatment, and the prognosis is good. The gravity of peripheral paralysis from injury to mixed nerves is therefore in proportion to the impairment of electric contractility and sensibility. The prognosis is also affected somewhat by the situation of the injured muscles, since parts farthest from the centers of nutrition recover last, and certain parts of the body are more inconvenient to treat than others.

TREATMENT.

174. When the impairment of function is due to compression or causes that have not impaired electrocontractility, the restorative action of static sparks is adequate. If pain is present, and especially if the circulation of the part is deranged, the sparks should be preceded by counter-irritant applications of friction or needle-spray. In more serious cases, the Leyden jar current should be employed after the method of labile faradization. In cases marked by extreme atrophy, coldness, and total paralysis, sparks are not indicated, and when employed will annoy rather than benefit. Great relief may still be given by static electricity employed as a local, high-potential, high-frequency bath. If, for instance, the ulnar nerve is the seat of the injury, fill an arm-tub with warm water, immerse the arm in it, and connect one end of the tub with the positive pole, and the opposite end with the negative pole.

Usually the positive is connected with the smallest contact. Use the smallest Leyden jars, and regulate the dosage to the comfort of the patient. The treatment, which should last 10 minutes, should be repeated three times a week. When warmth and nutrition are set up and maintained, and the muscles increase in size, the Leyden jar current may be used with ordinary electrodes and slow interruptions to give exercise to individual muscles. It should be observed that in the treatment of local paralysis due to injury there are sometimes complications—as cicatrices—that lessen the efficiency of static treatment.

LEAD PARALYSIS.

175. The distribution of the paralytic effects of chronic lead-poisoning varies greatly, but generally affects local groups of muscles. The diagnosis being fairly suspected or established, the usual prophylactic and eliminative measures should be prescribed. General static sparks on the spine and muscular surface of the trunk and extremities appear to aid the elimination, and their application is therefore a constitutional measure. Local treatment of the paralyzed muscles consists of setting up electrical contractions, as in the treatment of other forms of paralysis. Local sparks were used in the celebrated cases of Guy's hospital, and are commonly employed. When decided atrophy has taken place, local sparks are not only painful but have tissues to work on for which they are not suited. In such cases, the local application of Leyden jar currents by faradization methods or an arm-bath in wrist drop is more agreeable and more effective. The prognosis is good if the occupation is changed, but even when painters have been unable to secure other work, and have simply been more careful, they have been kept in a working condition for years by occasional periods of static treatment. Local potential alternation is useful for treatment of hand and arm.

NEURITIS.

176. Introduction.—**Neuritis** may be confined to a single nerve-trunk, in which case it is called *localized*, or it may attack simultaneously or in succession a number of nerves

neither anatomically nor physiologically related, in which case it is known as *multiple neuritis*. Neuritis is an inflammation of a nerve, and perineuritis an inflammation of the connective tissue surrounding a nerve. Either the localized or the multiple type may be interstitial or parenchymatous. Interstitial neuritis attacks the tissue between the bundles of nerve-tubules, and parenchymatous neuritis attacks the tubules themselves. The most frequent cause of localized neuritis is cold, and the nerve most frequently affected is the facial. Trauma and pressure are frequent causes of localized neuritis. It is sometimes caused by disease of bone through which the nerve-trunk passes. Toxemia, or toxic states of the blood, such as are found in infectious and constitutional diseases, as diphtheria, syphilis, and gout, and some of the mineral poisons, cause localized neuritis. Alcohol also produces localized neuritis, but it most frequently causes the multiple variety. Pain and tenderness along the nerve, and trophic troubles in the area of nerve-supply are the chief symptoms of neuritis. There is little, if any, constitutional disturbance. The duration of the disease varies; some cases get well in a few weeks, while some become chronic, and extend over months and years. In cases due to cold or trauma, the prognosis is favorable; when due to local suppuration, the prognosis depends on the damage sustained by the nerve, and the amenability of the local suppuration to treatment. The electrical reactions of nerves and muscles, and their importance in the prognosis of neuritis, are described in *Technique and Physiology of Direct Currents*.

Inflammations of the brachial plexus and of the sciatic nerve deserve special mention on account of their distinct symptomatology. Brachial neuritis is an inflammation of the sheaths of the branches that form the brachial plexus, and is most frequently encountered in gouty subjects well advanced in life. It is usually preceded by some manifestations of muscular rheumatism. Inflammation of the sciatic nerve will be considered elsewhere.

177. Multiple Neuritis.—The recognition of this disease and its separation from central nervous diseases belong to

modern times. Its symptoms were at one time attributed to poliomyelitis, and again to tabes or to bulbar affections. The importance of a correct diagnosis is very evident, for in poliomyelitis, tabes, and bulbar affections the prognosis is very grave, depending on a lesion of the central nervous system; whereas, in multiple neuritis, the prognosis is favorable, depending on a lesion of the peripheral nerves. Both the central and the peripheral lesions have symptoms in common; namely, paralysis of motion and sensation, trophic troubles, and pain. The lesion in multiple neuritis is an inflammation—acute, subacute, or chronic—of the small nerve-trunks supplying the muscles and skin in the regions where the paralysis, the atrophy, and the sensory troubles are found. The inflammatory process is most destructive in the smallest nerves. The destructive process diminishes in severity from the periphery to the center, both for the nerves of the skin and of the muscles.

178. Pathogeny.—The causes of multiple neuritis are the same as those of myelitis, and may be divided into predisposing and exciting. The predisposing cause is a neuropathic predisposition that may be hereditary or acquired; it is a very important factor in the development of multiple neuritis in preparing the way for the action of the well-known exciting causes, which may be grouped in two great classes: (1) infections; (2) intoxications. In the class of infections may be cited nearly all the infectious or contagious diseases—tuberculosis, typhoid fever, diphtheria, grippe. In the class of intoxications, alcohol is by far the most active of exciting causes. The other toxic substances are, arsenic, lead, sulfid of carbon, and nicotin. To these should be added the auto-intoxications of diabetes, gout, toxemia, and cancer. Cold is an important factor in the production of both localized and multiple neuritis. In studying the symptomatology of multiple neuritis, it is convenient to recognize these types: (1) the motor; (2) the sensory; (3) the ataxic. Individually, none of these types constitutes a case of multiple neuritis; they are all present in every case, but one type usually dominates the others in any given case.

179. The motor symptoms are, paresis of voluntary muscles, and difficulty of coordination; the non-striated muscles are very rarely attacked. The sensory type is characterized by pain, more or less severe, referred to the course and distribution of the affected nerves. The ataxic type presents the symptoms of tabes, and is frequently called *pseudotabes*. The lower extremities are most often the seat of the lesions, and the muscles most affected are the small muscles of the foot and the peroneal group. Muscular atrophy is a constant symptom of multiple neuritis, and develops at about the same time as the paralysis, but is much slower in its evolution. The tendon reflexes are abolished.

180. Prognosis.—If the cause can be discovered and removed, the prognosis is, in the majority of cases, favorable. The tendency of some cases to relapse must be kept in mind. In view of the relative benignity of multiple neuritis, every care must be taken to arrive at a correct diagnosis, and to avoid the error of mistaking multiple neuritis for grave central lesions presenting similar symptoms.

TREATMENT.

181. The first step in treatment is to ascertain the cause and remove it if possible. To ascertain the cause of multiple neuritis is often extremely difficult, and when the cause is known, it is not always easily removed. Alcoholics may go on drinking, notwithstanding the fact that they have been apprised of its deleterious effects. A metallic poison may be the cause of the trouble, yet its source may be for a long time undetected. A careful inquiry should be made into the previous history of the patient, with regard to infectious diseases, such as grippe or mild forms of diphtheria. During the inflammatory process, the most important part of the treatment is rest. The patient should be confined to bed and not allowed to perform any voluntary movements. The pain must be relieved, sleep procured, and complications carefully watched. When the regenerative stage sets in, electricity is the remedy most used.

182. While static electricity, preferably by counter-irritation and obtunding spark will temporarily relieve the pain in acute neuritis, yet it shortly returns, and to avoid frequent office-visits, patients are usually treated by other means, until the inflammation ceases to be active and chronic processes supervene; but no case is too acute to derive benefit from some form of static treatment with proper dosage. It may be stated as the result of practical experience that most cases of localized neuritis are best treated from the beginning by regulated static sparks, with assisting spray effects. Passing to the chronic stage of local neuritis, we find that the availability of the different forms of electricity varies with the part affected and the degree of loss of muscular excitability. In cases below the neck, static treatment is almost invariably superior, unless atrophy and loss of faradic reaction are present, when the galvanic current is usually preferable; or, if the part can be put into a local bath, the rapidly interrupted Leyden jar current is nutritional and restorative up to the point where contractions can be caused to hasten recovery. The late results of neuritis, which bring the patient to the electrotherapeutist, are paralysis and atrophy. In simpler cases of perineuritis and non-degenerative cases of interstitial neuritis, the paralysis is only partial and atrophy is negligible. Pain is the chief symptom that calls for treatment, and mild sparks are efficient.

183. In all cases in which Paquelin's cautery, blisters, massage, acupuncture, and similar measures are advised, the static spark is at once counter-irritant, anodyne, and muscle-contracting. After acute processes subside in severe cases, and from the beginning of mild cases, the static spray, made either sedative or counter-irritant to suit the indications, and the thick spark are very efficient remedies. When atrophy is marked, the limb cold, and faradic and spark reaction lost, the Leyden jar bath is even more effective and far more agreeable than the galvanic current, as usually employed; while for anesthesia the needle-spark is far superior to the oft-recommended faradic scourge When pain is worse from motion or position, the muscles should be placed in the aggravating

posture, and the current applied until relief is complete for that séance. Counter-irritant frictions are indicated in sub-acute stages. The method of potential alternation applied locally is recommended by some as being a superior means of treatment.

184. Prognosis.—Prognosis varies according to the severity of the acute inflammation, or to the length of time that has elapsed and the state of the tissues. In all cases it is improved by the use of static electricity in a proper manner. Mild cases are rapidly relieved.

DISEASES OF THE KIDNEY AND GENITO-URINARY ORGANS.

185. Kinds of Kidney Disease.—There are three chronic medical diseases of the kidney to which the student of static electricity should devote careful attention. These furnish the large white kidney, the contracted kidney, and the waxy kidney. The most frequent causes of lardaceous disease of the kidney are profuse and prolonged suppuration somewhere in the tissues or bones. It is thus secondary to the chronic cachexia of septic absorption. It therefore is usually accompanied by similar changes in the spleen and liver. Its symptoms and course resemble chronic parenchymatous nephritis. This latter is the "chronic diffuse hyperplastic process," involving the epithelium, glomerules, and interstitial tissue that develops the "large white kidney" that finally becomes fatty and contracting. This state of the kidney differs from interstitial nephritis, in which process the contraction is a granular degeneration with extensive destruction of the tubular substance and a growth of connective tissue.

186. Limitations of Treatment.—Now, if the physician closely studies these grave chronic lesions in standard works on "Practice," certain facts may be grouped together in connection with them.

1. There is no direct curative drug treatment for these lesions of the kidney.

2. It is essential to improve nutrition and the quality of the blood circulation, and aid the eliminative functions.

3. Symptomatic and palliative treatment is not only of great importance but furnishes a large part of the indirect benefit that occurs.

4. Hygienic measures are an important part of the management of a case.

When the patient is past remedy, and, with what aids to comfort medicine can give, awaits at home the final termination, there is no field for the use of static electricity; but from the moment the earliest diagnosis is made, and during all the time the patient could attend for office-treatment, this agent is of greater concern than is usually recognized. The student will observe that every detail of hygienic management can be carried out, every beneficial drug prescribed, every other effort made to protect the patient from complications, and improve his general condition and retard the renal process, without the slightest hindrance from the static current. This being true, then, the best-known medical treatment of any of these chronic diseases of the kidney can be unrestrictedly instituted, and to this treatment can be added the actions of static electricity.

187. Methods of Technique.—To select these according to the actions desired in a given case, the physician should study carefully the methods of producing special therapeutic effects. Potential alternation will steady and strengthen the heart, act as a sedative tonic to the nervous system, and to some extent aid in elimination. It also favors sleep. Symptomatic and palliative treatment can receive great aid from local applications of the various forms of breeze, spray, frictions, and sparks. For the relief of pains and to impart energetic tonicity to the general muscular system (hence benefiting the circulatory apparatus), static sparks skilfully (not abusively) applied are of greater value than any drugs that can be employed for approximate purposes.

Lastly, direct counter-irritations over the region of the kidneys and the spinal-nerve supply, by means of the sand-blast spray as administered by Doctor Monell, of New York, appear to

produce reflex effects on the kidneys and the morbid process that are clinically valuable. The effect of 2 months' regular treatment on the constitutional condition of a patient in the septic state produced by an old bone suppuration—one of the states out of which lardaceous kidney may develop—can only be appreciated by those that have seen it. The student is advised to carefully investigate the relations of static electricity to chronic diseases of the kidney, supplementary to general rational therapeutics, diet, and hygiene. Owing to the intimate relation between cardiac and renal lesions, it is also important to study the regulating and tonic action of static electricity on the heart. Administer a few short thick sparks of very small voltage directly upon the chest wall over the apex of the heart and also upon the cardiac centers of the spine. In doing this never hurt or distress a patient.

CHRONIC CYSTITIS.

188. As an adjunct to the usual management and therapeutics of **chronic cystitis**, the patient will derive some symptomatic relief from a sharp counter-irritant spray over the lumbar spine and region of the bladder. It is often useful to follow the spray with mild sparks.

NEUROSES OF THE BLADDER.

189. Causes.—Hyperexcitability of the sensory reflex center or local irritation may set up spasms of the vesical sphincter. Nervous spasm or paralysis of either or both the detrusor or sphincter muscles may occur. A standard authority refers many symptoms of the genito-urinary neuroses to an exalted reflex excitability, caused by overstrained physical and especially by exciting mental activity long maintained. Grief, fright, pain, business anxieties or losses, sexual excess, and masturbation are cited as neurotic causes. The urine is normal in character, though often irregular in its secretion. There may be hyperesthesia or anesthesia of the vesical mucous membrane. The above class of cases is not rare, requires an exceedingly careful diagnosis, and includes cases that are "often difficult to cure by medical means."

TREATMENT.

190. Static electricity is seldom called on in the treatment of ordinary cases of retention or incontinence of urine. In cases in which electricity is usually indicated, the galvanic or faradic currents are more commonly used than the static, and have different advantages in conditions to which they are best suited. In selected cases, however, static sparks may be applied to the perineum and to the lumbar centers to restore normal functions in enuresis. Localized potential alternation, rapidly interrupted, dosed to comfortable tolerance upon the perineum, has been found useful in these cases. A spark-gap of about an inch is employed. The chief indication for static electricity in these neuroses as in others is to diminish the "exalted reflex excitability"; to restore the nerve and muscle tone after "overstrained physical activity"; to restore the tonic equilibrium after fright, grief, and pain, and to remove pain if it exists in a form amenable to this current; to counteract the effects of masturbation and excessive venery; and to establish a healthy substitute for the neurotic state. These functions it is efficient to fulfil if employed by well-taught methods, and disturbing symptoms will speedily disappear in many cases that have resisted medication.

IMPOTENCE AND SPERMATORRHEA.

191. The forms of these conditions that can be benefited by the administration of static electricity may both be considered together. Galvanic and coil currents have a wider range of local usefulness in some varieties of impotence, but general indications are often best met by static electricity. Cases of partial or complete acute and subacute impotence resulting from functional derangements, illness, anemia, neurasthenia, physical prostration, overtax, and allied causes are well treated by tonic static sparks to the spine, general muscular system, and perineum. The interrupted static current (potential alternation) is also employed locally upon the perineum with varying rates of interruption both rapid and slow. It has an excellent tonic action, and is more agreeable than direct sparks.

Supplementary measures are nearly always required. Whenever an improvement of the genital functions depends on an upbuilding of the general nervous and physical forces, then static electricity is indicated. It helps take the mind away from morbid brooding in cases that have been in the depths of despair from reading literature about youthful errors.

DISEASES OF WOMEN.

192. Gynecological Uses of Static Electricity. While a static machine and a skilful operator are indispensable to securing the best results in the office-treatment of chronic non-operative diseases of women, yet this is true more from its ability to treat the patient than from its action on the pelvic organs. The immensely valuable local methods of electrogynecology unite the uses of galvanic and fine induction-coil currents. The great function of static electricity is to improve the general health; tone up nerve- and muscle-tissues; relieve pains, headaches, backaches, reflex neuroses, neuralgias, and mental worries; promote sleep, appetite, and digestion; and in all ways within its physiological properties increase the state of comfort of the patient. The extent to which it serves these purposes depends on the skill of the operator, hence a careful study of *Technique and Physiology of Static and Other High-Frequency Currents* is of utmost value to the physician. It is conservative to say that physicians who attempt to use their static machine without proper instruction in methods do not get 10 per cent. of the monetary value out of it, and also do an injustice to their patients.

The special actions of static electricity secure therapeutic effects sought for by the common recommendations of counter-irritation, plasters, blisters, hot and cold applications, liniments, massage, travel, climate, rest-cure, mineral springs, hydrotherapy, drugs, sedatives, anodynes, nervines, tonics, etc., apart from the direct local indications within the pelvis. These effects are obtained without removal of clothing or exposure of the patient, and with greater certainty and facility than some other measures permit. For the treatment of neurasthenia and other

morbid entities associated with pelvic lesions, the methods are the same as described under proper titles in other Sections of this Course. In addition, the more direct gynecological uses of static electricity will now be stated.

193. Simple Amenorrhea.—In this disease, positive electrification should be used, followed by stimulating spray, frictions, or mild sparks to the spine over the ovaries. In chlorosis, anemia, and cachectic conditions, other measures should not be neglected.

194. Menorrhagia.—As a general tonic to combat debility and nervous symptoms resulting from hemorrhage, the static current is useful as an adjunct to other measures to control the bleeding. Potential alternation and sedative-tonic spray to the spine are indicated.

195. Menstruation in General.—This period is not a contraindication for sedative or general tonic methods of employing static electricity in patients undergoing treatment apart from pelvic lesions.

196. Dysmenorrhea.—Cases of simplest forms of discomfort or nervous irritability, coldness, and neurotic and circulatory disturbances are all comforted, warmed, and composed by positive electrification or potential alternation. Often a sedative breeze to the spine or head is useful. Severer cases dependent on uterine lesions require direct treatment.

197. The Neuroses of the Menopause.—Special indications must be met to suit the case. Sharp counter-irritation by static frictions on the cervical spine followed by a sedative breeze does much to relieve the tension of nervousness. Great symptomatic relief can be given during this period by the judicious use of static electricity. Sparks around the pelvis will often start the flow when a little stimulus to innervation is needed.

198. Neuroses and Cachexias at Puberty.—At this important time of life the boy or girl may be functionally regulated, nerve and muscle tone brought up to par, and tissue resistance established by general and local tonic methods of

employing static electricity. This would prevent much of the functional ill health that delays children in school, gives them headaches, and makes them a prey to the invasion of disease. In this field alone the value of static electricity is incalculable, and appreciative study may well be given to its physiological actions.

199. Chronic Uterine Displacements, Tumors, Inflammations, and Associated Ill Health.—Few patients with chronic uterine lesions are otherwise well. Many of their symptoms cease on local treatment with galvanic and induction-coil currents. Many, however, require supplementary measures. Probably the one agent, static electricity, will more adequately promote the strength and comfort of these cases after local applications than all other resources of materia medica combined. The indications must be met as they arise. Methods cannot be stated in advance in definite terms.

200. Backaches.—These are frequent and numerous in women and are practically all disposed of by the static spray, frictions, or sparks, as needed in any given case. Should an obstinate case resist these, the rapidly interrupted, high-tension induction-coil current will be effective. In obstinate cases the cause must be sought and removed.

201. Ovarian Neuralgia and Obscure Pelvic Pains Dependent on Disordered Innervation.—The reflex effects of a sharp counter-irritant static spray interspersed with sparks on the area of pain often relieve the pains more or less permanently, without medication or local intrapelvic applications.

202. Pregnancy.—This state is not a general contraindication for static electricity. On the contrary, many of the symptomatic disturbances occurring during pregnancy may be relieved by suitable applications. It is also especially valuable in restoring strength in debilities following parturition, during tedious and exhausting cares while nursing, and at all periods of woman's life when her health is deranged by social and domestic trials.

203. Uterine Fibroids.—Patients that have fibroid tumors of the uterus often require other treatment than either the reduction or removal of the tumor. The following extract, quoted from Doctor Monell's work on "Treatment of Disease by Electric Currents," expresses the relation of the static current to such patients:

"It combats the symptoms of general debility, backaches, neurasthenia, insomnia, and nervous disturbances without waiting for the slower action of electrolysis. Its value cannot be appreciated until its effects are witnessed. It is a tower of strength to rely on in the office and in the hospital where pelvic diseases are treated; and in imparting strength to weakened muscles, in improving digestion, promoting sleep, and releasing the patient from the bondage of sedatives and hypnotics, it acts as a restorative agent of very great practical value."

In the equipment of a physician's office it would be difficult to name another single instrument that is so great a boon to suffering womanhood as a skilfully handled static machine.

DISEASES OF THE SKIN.

204. The utility of static electricity in dermatology is not appreciated. The action of static methods on the functions of the skin is visible in every static treatment. The nutrition and function of any organ depend on the quantity and quality of blood that enters it. The circulation in the skin is readily modified by static methods.

The **diseases of the skin**, as pointed out by Walker, do not differ in their processes from those of other organs. The skin contains about the same anatomic elements as other organs, and is therefore amenable to the same disorders. The morbid process is modified in its symptoms by the anatomy and physiology of the involved organ. An attack of acute indigestion may show itself by pain and nausea, referable to the stomach, and, at the same time, as an urticaria of the face with itch, burning sensations, and the usual characteristic symptoms referable to the skin. The vascular disturbance and the essential pathological processes do not differ in both organs.

205. The great majority of cutaneous diseases belong to inflammatory classes, and the pathological processes in inflammation of the skin differ in no way from those found in inflammation of other organs. The skin, through its position, is always exposed to irritating agents, but it is so from birth, and acquires a capacity for resisting irritants not found in other organs.

Just as in other organs, there are found, in the skin, hyperemia, and anemia, hypertrophy and atrophy, congenital malfarmations, tuberculosis, carcinoma, and sarcoma. The health of the skin depends on the quantity and quality of its blood-supply and the normal function of its anatomic elements, the nerves, lymphatics, blood-vessels, muscles, and the epithelial and connective tissue that enter into its formation. A change in the quantity or quality of the blood-supply—a disturbance of the function of the anatomic elements—if sufficiently marked or prolonged, becomes pathological and causes disease.

The effect produced by static electricity on the circulation of the skin, and its demonstrated power to influence the functions of its anatomic constituents are *a priori* reasons for its therapeutic application in nutritional and inflammatory cutaneous disorders.

206. Physiology of the Skin.—The functions of the skin are: (1) it protects the deeper tissues; (2) it is an excretory, a secretory, and an absorbing organ; (3) it is a sensitive organ in the exercise of touch; (4) it assists in regulating the temperature of the body. All these functions, with the exception of the first, are directly controlled through the cerebrospinal and sympathetic nervous system. One of the chief physiological actions of static currents is their power of regulating and controlling functions through their action on the nervous system, and the functions of the skin form no exception to this physiological action of static electricity.

The uses of static electricity as an adjunct to general or local treatment are as follows:

207. Alopecia Areata.—Sedative head-breeze to relieve pains if present; concentrate a strong positive spray (rich in

ultraviolet chemical action) upon the affected area; potential alternation or mild general sparks for tonic and nutritional effects.

208. Acne.—Short thick positive sparks, dose regulated to avoid all pain (length of spark from ¼ to ½ inch, with voltage much reduced), applied over affected surface and especially to each focus. Stimulating mild sparks and frictions to spine, region of liver, and parts indicated. Stimulate gastric functions. Meet all constitutional indications. In sparking the face avoid teeth with metallic filling. With proper care superior results may be obtained without taxing the tolerance of the patient.

209. Anesthesia, Localized Areas of.—Stimulating needle-sparks to the area affected in mild cases. In severe cases apply fusilades of sparks until sensation is aroused and irritate the terminal nerves with hot frictions.

210. Cancers, Superficial Ulcers, and Slow-Healing Suppurating Lesions.—The deodorizing, pain-relieving, and healing actions obtained with X-rays and chemical rays of light can be equally obtained in suitable cases by the application of a concentrated, strong, ozone spray from the positive pole of the static machine, supplemented when indicated by nutritional mild sparks upon surrounding areas to promote accessory effects. The action from the spray can only be expected when the skin is open to the application. An internal tumor covered by sound skin cannot be reached by the static spray. Test upon suitable cases with a properly dosed spray and supporting sparks will demonstrate the long neglected value of static electricity in these ulcerations.

211. Carbuncle.—As auxiliary to the usual surgical principles, incision and evacuation of pus when needed, etc., apply a sedative, positive, static spray to relieve pain. Use a more stimulating spray and very mild sparks around adjacent tissues to promote granulation, when the stage of healing is reached. To improve the general health, use potential alternation or general tonic sparks.

212. Dermatalgia.—Anodyne spray locally, and general tonic sparks or potential alternation for constitutional effects. Counter-irritant frictions are often useful both on the spinal centers and over the affected nerves.

213. Dermatitis.—Sedative breeze to relieve pain and allay inflammation. Dosage is most important. Avoid a spray discharge that will leave a secondary heat and increase of blood in the capillaries. Connect the patient by chain directly to the negative pole. Use a carefully polished and fine brass-point electrode, or fine copper-needle electrode, held at a short distance from the bare skin. The distance depends on the rate of current generation. With an ordinary current the point may be about 2 inches from the tissues. Maintain the application until the effect is produced. Repeat frequently until the process is checked.

214. Erythema.—Sedative applications of the breeze or spray may assist other measures for the cure of all forms of erythema. For erythema nodosum, apply a few short thick sparks directly upon each focus of the disease and then reduce the heat, etc. by a cooling breeze. Build up the general health by potential alternation, tonic frictions to the spine, nutritional sparks, and all indicated measures. The results are excellent.

215. Epithelioma.—These come under the forms of surface neoplasms that can be benefited measurably by the sprays of static electricity, which are rich in ozone and ultra-violet rays. What is said in Art. **180** applies here. It should also be noted that lesions which are overtreated by X-rays by operators not fully skilled in dosage will be controlled and helped to heal more kindly by the intercurrent use of static sprays as instructed.

216. Eczema.—Local sedative or stimulating sprays, according as the state is acute or chronic, in conjunction with constitutional measures. A sedative breeze will often remove the itching. A thin current is not very effective in obstinate cases. A thick spray discharge concentrated on the affected area is valuable treatment. In old crust-covered cases, the

scales must be softened and removed by the usual methods before the current will heal.

217. Furunculosis.—Mild single sparks on each blind boil in crops of furunculosis either scatter the stasis or promote suppuration and healing afterwards. Sedative sprays relieve acute pains of more marked inflammation. In single boils the spark will hasten suppuration and must be supplemented by usual dressings and treatment for the evacuation of pus. Tonic general sparks to the muscular system and spine to promote the general health.

218. Herpes Zoster.—Sedative spray for symptomatic relief in acute stage. General tonic methods in chronic cases with debility and ill health. Is not a direct specific for the disease, which runs its course but with less severity.

219. Lupus.—What is said of cancers, ulcers, etc. applies to lupus. Much can be done in suitable cases by proper static sprays, both singly and in alternation with X-rays and electric-light treatment. For ordinary use the spray has advantages, but must be a thick current to be fully effective.

220. Pruritus.—Sedative spray interspersed with mild sparks on the uncovered skin will often relieve or modify severity. For anal cases local potential alternation with Doctor Monell's rectal electrode improves the venous circulation and often gives long lasting relief.

221. Psoriasis.—General tonic spark applications to build up the general health as an adjunct to other measures, especially the X-ray. Ordinary static applications to patches of this disease do not cure it.

222. Red Nose.—The simple redness that some people complain of may often be much lessened by attention to the portal circulation and a static spray upon the nose. Use a thick concentrated positive spray for 5 minutes. Repeat for a few times.

223. Scrofuloderma.—General tonic and alterative sparks to muscular surface to improve the general health. Mild

sparks on the enlarged glands. Most glandular enlargements of a non-malignant nature will resolve under the stimulating action of mild static sparks. A localized potential-alternation method can also be used with great benefit. The action of the rapidly interrupted high-potential application is similar to the familiar sedation and nutritive-tonic effects of long fine-wire coils, but has a much higher voltage and deeper action.

224. Tinea Tonsurans.—Apply a concentrated positive spray with a thick current that is rich in germicidal ozone. Curative results have been obtained that closely resemble the results of X-rays.

225. Ulcerations, Acute and Chronic.—Sedative spray to relieve congestions, pain, and soreness; later, more stimulating sprays to promote granulation, with mild sparks on surrounding tissues to improve local circulation. General tonic and alterative spark-treatment for constitutional effects in cachectic states from septic absorption, and all negative rundown conditions. As an adjunct to the usual dressings and treatment of ulcers static electricity is of very great value. This applies to all forms that are accessible.

226. Urticaria, Chronic.—Sedative spray to relieve itching. General tonic eletrification for nutritional effects as adjunct to diet and usual medication. Mild sparks and counter-irritations over region of liver are useful.

ELECTRICITY IN DENTISTRY.

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INTRODUCTION.

ADVANTAGES OF ELECTRICITY.

COMMERCIAL ELECTRICITY.

1. No profession or art has such varied demands for its successful practice as dentistry, and no single agent meets more of these requirements than electricity as at present developed. In the past the only practicable applications of electricity were such as could be derived from battery power, but the output of the battery as a source of electric energy was so small, as compared with its bulk, that even the space it occupied was no small consideration. The care necessary to keep it in good working order was a burden, and the great complication of the parts made electricity a formidable and uncertain agent. On this account, if the dentist used electricity at all, his battery consisted of but a few cells, and he was content to use only such instruments as required but little electric energy to operate them. In fact, the first applications of electricity were in the form of light power, such as would operate the armature in the shocking machine, or, later on, the electric mallet, cautery, and mouth-lamp.

2. Commercial Electricity as a Substitute for Batteries.—Although the battery, as a source of electric energy, was practical and successful in the hands of a few that understood it, it has not proved so in the hands of the majority, and

this has cast a shadow upon the advent of commercial electricity as supplied to us at this day. Many, no doubt, have hesitated to install modern electricity in their practice for no other reason than that it has not been a brilliant success as supplied by the battery power of the past. But the beginner should bear in mind that he has no longer to do with the making of the energy, but with the use of it as furnished to him by two or three wires. The generating of commercial electricity has become an industry engaged in by corporations and companies for the supply of cities and towns, and the operation of an electric plant on a small scale has been made so simple that many public buildings, hotels, and private residences operate their own.

3. Precision With Which Electricity Is Used.—While we cannot yet say with certainty what electricity is, it has been found, however, to produce results as accurate as those obtained by the application of a rule in mathematics, and, when it is properly understood, it can be depended upon. A given current forced through a known conductor under a given pressure always produces the same amount of magnetism in an iron core, the same rise in temperature in the conductor, or deposits the same quantity of a metal from its solution. A current of 7.46 amperes flowing under 100 volts pressure is an energy equal to 1 horsepower. The heat produced by burning a given quantity of ethyl alcohol can be quite closely calculated, but not so easily or accurately as the heat produced by electrically heating a conductor. It is possible for the electrician to figure with pencil and paper, beforehand, the exact amount of heat that will be produced by the various arrangements of quantity, pressure, and resistance; or, a given current, it has been found, will deposit a given quantity of metal from its solution in a certain time. One ampere will deposit 4.024 grams of silver in 1 hour.

4. Measurement of Current.—These results always follow the operations of electrical energy, and are so accurate and ever present that they are made the basis for the measurement of electricity. The different forms of the voltmeter, ammeter, and wattmeter are constructed so as to operate under

one of these laws, or a combination of them. In the electromagnetic meter, the current is measured by the electromagnetic effects; in the electrothermal meter, it is measured by the increase in the temperature of a resistance through which the current passes, or by the evaporation of a liquid heated by the current; or in the electrochemical, by the electrolysis of the solution of a metallic salt, the deposit being weighed.

5. Accuracy Required in Dental Practice.—Nearly all operations in dental practice require the utmost accuracy in the application of energy, whether in the form of power, heat, light, or chemism, and as seen from the foregoing, the principle of the characteristics of electricity is the identity of its operations under like conditions. Not only this, but the perfection and ease with which its action may be regulated or varied for different degrees of intensity, are important considerations. The speed for revolving the burr, the heat for the desiccation of dentin, for softening gutta-percha, for annealing gold, or for fusing porcelain should be easily varied to suit each case at hand.

6. Control of Electric Appliances.—These conditions are not always alike, and electricity obeys the throw of the rheostat lever so accurately that, as if by magic, the will of the operator is felt at the instrument under operation. After a little experience, his control over each appliance through the rheostat becomes almost automatic. The pianist, in reading a piece of music, does not think of the movement of each of his fingers as they glide over the finger-board, or of the management of the pedals with his feet, and so it is in the manipulation of a well-constructed electrical instrument. There is no effort at calculating how a certain thing is to be accomplished, but quite involuntarily the mental image of what is to be done is transformed into the deed itself. The electric dental engine, as perfected today, increases or decreases its speed, stops or reverses at the touch of the operator, and does all this so easily that it requires little effort on the part of the operator, the mental routine ceases, and the control becomes automatic. The attention of the operator, instead of being divided between

the instrument and the operation, is now concentrated upon the latter.

7. Constant Pressure of Commercial Current.—The pressure of commercial current, as used for incandescent lighting, is practically steady, so that each contact button of the rheostat always gives the same rate of speed to the engine, or the same heat to heating appliances, and by a glance at the rheostat the rate of current-flow is noted.

8. Simplicity of Regulation.—A predetermined requirement of energy for a given purpose or instrument can always be accurately obtained, thereafter, by using the same contact button. The flow of water from a faucet, or of gas from a burner, cannot be more accurately regulated than a current of electricity by means of the rheostat. The great variety of appliances that can be made for modifying the strength of the electric current, the accuracy of their gradations, and the perfection of control at once make it possible to use the same current for the heaviest motor work or the most delicate cataphoresis. No energy at our command has such a wide range of action and is at the same time so easily and accurately regulated as electricity.

9. Cleanliness.—The cleanliness of electricity is another prominent characteristic, and this is especially desirable in dental practice. The older forms of power, except foot-power, when used at all, were obtained by the combustion of oil or gas, or by the use of a water-motor. While the gas engines were generally satisfactory, the odor of the oil or gas would, in time, fill the apartment, and the complication of parts was sometimes a source of trouble. The water-motor was cleaner but water-power was not always available. The one thing prominent in the use of electric energy is the cleanliness that may be preserved in whatever form it is used. Wherever there is friction in machinery there must be a lubricant, and wherever there are many moving parts the difficulty of preserving cleanliness is often serious. In the electric motor, the two bearings of the armature shaft are the only parts that require oil,

and, since the motion here is rotary, there is little danger of the oil being thrown about. In well-constructed motors the bearings are not only continuously oiled, either by a revolving ring or by a wick, but the whole bearing is so constructed that the surplus oil finds its way into a drip-cup. A $\frac{1}{8}$-horsepower motor can be placed at any convenient point about the chair without any danger of soiling the immediate objects.

10. Superior Qualities of Electric Light.—The electric light has advantages over other forms. It, too, is without dirt or odor. The atmosphere is not robbed of its oxygen, nor is it vitiated by the products of combustion. A small light can be enclosed within the mouth without discomfort, or a large one may be poised in any desired position about the chair. The heat radiated from the incandescent bulb is not enough to set fire to objects with which it may come into contact, so that it can often be used where a gas or oil flame would not be permissible.

11. Production of Pure Heat.—While the cleanliness of electrical heat would alone recommend it for use in the dental office, there are some processes in dental practice to which electrical heat by its purity and wide range is especially adapted, as for instance, its purity for annealing gold, or fusing porcelain, or its wide range, from the softening of gutta-percha or warming water, to the melting of porcelain or platinum. Pure heat is of solar origin, and yet when heat is produced by electrically heating a conductor that does not oxidize or undergo any change, as in the case with one constructed of platinum or iridium, it is practically pure. It is without gas or odor and can be easily regulated. The range of electrical heat depends on the manner in which it is produced. If it is produced by the resistance of the conductor, then the highest limit of the heat will be the melting-point of that conductor. If platinum or iridium is used as the conductor, the range of heat will be between zero and the melting-points of these metals, or about 3,600°. If it is the heat of the arc it will be nearly 6,000° F. While the latter is the most intense heat that man can produce,

it can at the same time be manipulated between the two hands of the operator without inconvenience or danger to life, again illustrating the fitness of electricity in dental practice.

12. Decreased Noise and Vibration.—A feature characteristic of electric energy is the very small amount of noise in its operations. As a matter of fact, there is no noise in any operation of electricity itself when properly used except the arc tone or the sharp report following a voltaic discharge. The sputtering of the arc light is due to bad carbons or imperfect adjustments, and the noise of the motor is due more often to badly shaped armatures and poor adjustment of the brushes than to the flow of the current. These are the faults of the instruments themselves and not of the energy that operates them. But even a bad electric motor produces no more noise than the very best water-motor of the same horsepower. The engines operated by gas, oil, or steam are ordinarily reciprocating engines, and wherever there is a change in the direction of the movement of any mass of metal, as there is in the pistons and valves of these engines, vibrations will be set up in the whole machine and in adjoining objects that produce the noise and jar characteristic of these engines. With the electric motor, however, the motion is rotary, and the only sound from a good instrument is the hum produced by the air friction of the armature, or perhaps the friction of the brushes upon the commutator. The noise of the electric mallet is due to the weighted armature coming abruptly against hard substances in either direction of its swing. But since the force of each blow depends on the sudden impact of one moving mass against another, the sound thereby produced will always be present.

The other operations of electric energy are without any audible sound. An oven may be heated to the melting-point of platinum, and there may be a horsepower of energy in operation, but it cannot be heard. The incandescent light glows and all galvanic processes go on without sound.

13. Care of Apparatus Reduced.—When the dental office is equipped with commercial electricity, as at present supplied, the current becomes as reliable as the water or gas, and

the dentist is relieved of much care. Then, too, the instruments for using the current are highly perfected. The current is supplied at a given pressure, which is maintained at all times with wonderful accuracy. The instruments using it are made to operate with this pressure just as a gas-burner for gas, or a water-motor for water. With an electric system operating at 110 volts pressure, a lamp, when burning, plainly shows a departure of 5 volts in either way from the standard. For this reason, the operator need not at any time be concerned about the working of his electrical instruments when they are used upon the current for which they are intended. His supply is always uniform, and he need only see that the connections are properly made. The electric light requires no care to keep it in order, and the motor needs only to be kept clean and oiled occasionally. The heating appliances require no special attention, and the other operations of electricity go on with like freedom from care on the part of the operator.

Another feature that commends the use of electricity in dental practice is the flexibility of the system. Wherever water is used in an office it is necessary to convey it by a system of piping. This not only necessitates removing part of the floor or ceiling, but the danger of leaks occurring at points difficult of access is always present. Any additional fixtures require great expense and discomfort until the pipes are concealed. The same that is said of water-piping applies also to gas-fixtures.

14. Wide Range of Adaptability.—If water is used for power, the customary method of transmitting the power from the motor to the lathes is by a system of shafting, so that it is not easy to extend it to adjoining rooms, or to any great distance. When a single motor is used for all purposes, as is generally the case where water-power is used, it is often necessary to set the whole line of shafting in operation for the smallest as well as the largest piece of work. With the electric system, however, it is quite different. Any change or extension of the electric wiring of the apartment is much more easily made than in the case of pipes. Instead of removing part of the floor or ceiling for this purpose, the wires can often be laid

or pushed through between the floors or walls. The manufacturers have produced so many convenient appliances for outside or open wiring that it is not always necessary to conceal the wires. They have also simplified matters by the use of the flexible cord so that a motor, lamp, or any instrument or appliance can be quickly attached to a fixture and placed at will. The electric fan can be attached to a lamp-socket and placed in any suitable position with no further trouble than that of screwing in the plug. For lathe work, instead of having one large motor, as is necessary when using water-power or the gas engine, several motors may be used, each one adapted and belted for the particular use for which it is intended. Thus, one for grinding and polishing in the laboratory, one for condensing air, and one for the operating chair is a luxury not realized from any other form of power.

15. Safety in Use of Electricity.—For a time after the introduction of electricity there were many death accidents from this agent. This led to the belief that the dentist would endanger his life by using electricity in any other form than that for which it is commonly used—light and power. But he should bear in mind that all the practical uses to which he can put it do not require a high voltage, and that the currents ordinarily used for incandescent lighting meet every requirement. The pressure of these currents does not exceed 220 volts, and while some persons, under favorable conditions, might be unpleasantly shocked by this current, it is not regarded as a dangerous one. But a current of 220 volts is not ordinarily used for lighting. In the three-wire system it can be obtained by connecting the outer wires, but the lamps are usually placed between one of the outer wires and the middle wire, which gives but one-half of 220, or 110 volts. In the ordinary wiring of buildings it would be by accident entirely that a person would make a contact between the outer wires and receive 220 volts. When the alternating current is used the voltage is often as low as 48. Currents of over 220 volts pressure are not only dangerous to life, but they possess no practical value over lower voltage currents for dental purposes. The 500-volt current may be used for

power, light, or heat, where the lower pressure currents are not available, but this is regarded as a dangerous current, since there have been deaths from it under favorable conditions, and the dentist should protect himself by means of automatic appliances, which make it an impossibility to get the full current-strength through thoughtlessness on his part.

LIGHT.

THE ELECTRIC LAMP.

16. Convenience of Electric Lamp.—The nature of the dental office calls for a clean and safe light. The electric light does not rob the air of its oxygen and does not vitiate it with the products of combustion. An electric light can be placed at any convenient point about the chair and in positions where a gas-flame would be impractical. A 50-candlepower lamp may be poised within a short distance of the patient, or a 2-candlepower lamp can be used within the mouth without danger or discomfort to either patient or the operator. Moreover, the ornamental style in which electric-light fixtures are now supplied, permits of many pleasing designs for lighting. An ornamental figure can be made to hold a chain of series-lamps, or another figure can be used for holding a large lamp for the chair. While these fixtures are highly useful to the dentist, they are also pleasing to the patient.

17. Construction of Lamp.—The incandescent lamp consists of a carbon filament enclosed in a glass bulb. In order to produce light, the filament must be raised to a very high heat. If this were done in the atmosphere, the carbon would be consumed. For this reason, the filament is enclosed in a glass bulb from which the air has been withdrawn. At the small end of the bulb, two pieces of platinum wire are sealed in the glass, to the inner ends of which are attached the two ends of the carbon filament, and to the outer ends two copper wires, which are soldered, one to the threaded shell of the base, and the other to the button in the middle. When this is screwed in a socket, electrical connection is made with the mains.

18. The Filament.—Carbon is used for the filament because it will withstand a very high heat when excluded from the air. The filament in a 16-candlepower, 110-volt lamp, is about 7 inches long, and $\frac{6}{1000}$ inch in diameter. This has a resistance of about 220 ohms, and such a lamp is usually estimated to consume about $\frac{1}{2}$ ampere.

19. Life of the Lamp.—The average life of an incandescent lamp is estimated at 500 hours. If it is used on a current whose voltage does not rise higher than that for which the lamp is intended, it will last much longer than the foregoing estimate. A few moments of over-voltage will soon ruin a lamp. During the life of a lamp it is most efficient at first, and gradually diminishes, until, if it does not burn out, it becomes worthless because of its increasing resistance and because of the blackening of the inside of the bulb by a deposit of carbon. The lamp gives but little light and consumes so much current, comparatively, that it should be exchanged.

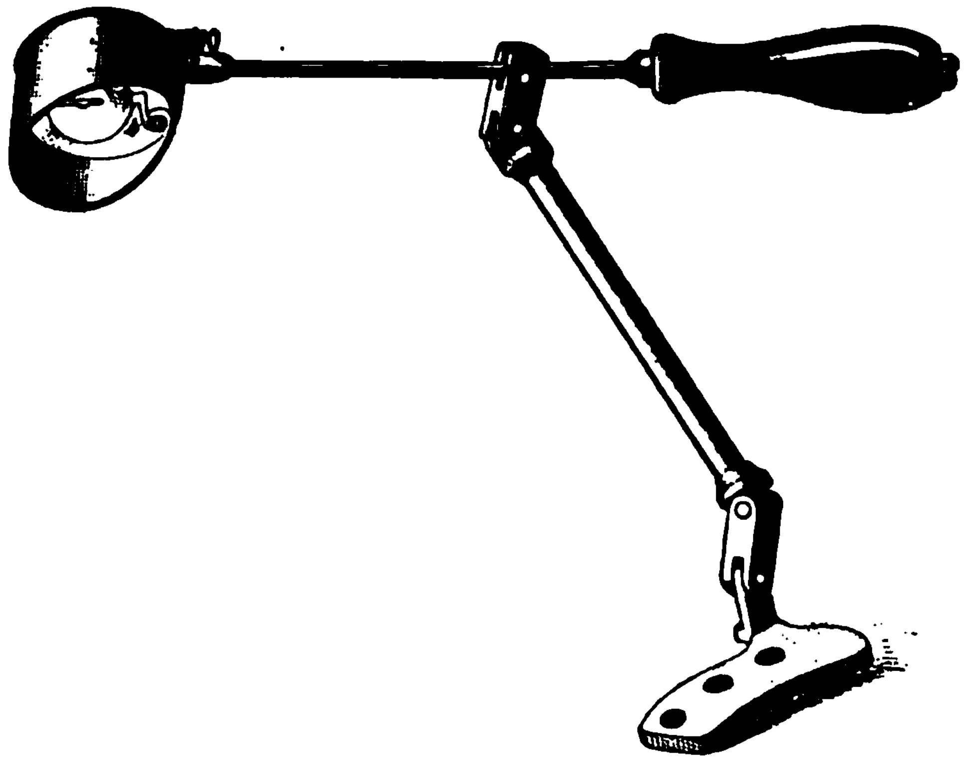

FIG. 1.

S. S. White Lamp for the Head-Rest.

20. Miniature Lamp.—The miniature lamp is constructed in precisely the same manner as the larger ones, except that all the proportions are much smaller. This form of lamp when properly mounted makes a mouth-lamp, which is one of the most important dental adjuncts.

21. S. S. White Lamp for the Head-Rest.—The electric lamp makes the ideal light for the dental chair. It is an easy matter to poise one at a convenient distance and position from the patient. One of the first lamps upon the market for use as an operating lamp is that made by the S. S. White Dental Company, and is shown in Fig. 1.

This lamp is to be attached to the head-rest. A plate is permanently fastened underneath the same and the lamp

FIG. 2.
Victor Head-Lamp

support is quickly sprung into this by means of a slip-joint. The lamp first supplied with this appliance was one of about 4 candlepower, which was used in series with a larger lamp for resistance. Since that time the lamp manufacturers have so improved in their construction that an 8-candlepower lamp can be made small enough to be contained in the reflecting hood. The latter lamp needs no extra resistance.

22. Victor Head-Lamp.—The Victor Electric Company supplies a lamp, as shown in Fig. 2, which is to be worn on the

head. In some respects this is the ideal lamp. It casts no shadow and the operator has, at all times, good illumination of the field in operation.

23. Stereopticon Lamp.—The General Electric Company supplies a 50-candlepower lamp for stereopticon purposes, and when this is mounted on a flexible bracket arm, such as may be had at any electrical supply house, it is a most convenient and efficient fixture. A reflecting shade can easily be adjusted to the lamp-socket, which may be turned at such an angle as to intensify the light and at the same time shade the patient's eyes.

FIG. 3.
Stereopticon Lamp.

24. Illumination of the Mouth.—The lamps just referred to are for use as general operating lamps, for dark days, and at the close of the day, and are best operated on commercial currents. The miniature lamp is to be used within the mouth, and especially for the purpose of examination and diagnosis, for the detection of pulpless teeth, engorgement of the antrum, and of cavities, especially those between the teeth. The extent of many abscesses can often be outlined by this means. The miniature lamp is to be used as often in the daytime as upon dark evenings, and may be operated upon either the commercial current, with the proper resistance, or by a small battery.

25. S. S. White Mouth-Lamp.—As with the head-rest head-lamp, the S. S. White Company were among the first to introduce a lamp for the mouth. This, as shown in Fig. 4, consists of a handle with the lamp and reflecting mirror at the end. A feature of this lamp is the convenient device for regulating it. A small rheostat is made a part of the handle, whereby the

lamp can be easily and quickly adjusted for the strength of the current by the simple sliding of the ring seen near the middle of the handle. This lamp may be operated by a few dry cells or upon the commercial current in series with a 32- or 50-candle-power lamp.

The Ritter Dental Manufacturing Company supplies a mouth-lamp, which is shown in Fig. 5 The lamp is encased in an aluminum handle and shield, making it light and clean. This lamp is intended to be operated by dry cells, which are encased in the wall cabinet to the left.

FIG. 4

S. S. White Mouth-Lamp.

26. Victor Mouth-Lamp. The Victor Electric Company, also, has a mouth-lamp on the market. This has been equipped for both the commercial current and for battery use. The lamp is encased in the end of a long tube, so constructed that the current cannot reach the patient in case of any accidental grounding of the wires. When it is to be used upon the commercial current, a lamp is used for resistance, as shown in Fig. 6.

27. Switch for Operating Lamp. The mouth lamp not being an every-day necessity, the makers have provided for this by using a Vetter current tap base upon the lamp, which makes a complete outfit ready for use when screwed in an ordinary lamp-socket. When the lamp is to be operated by a battery it is supplied with a foot-button by which the lamp can be operated intermittently, a convenient feature in many instances It, moreover, saves considerable current, an

item not to be overlooked when the lamp is operated by a battery, for in practice the lamp without a switch is burned as much out of the mouth as it is within it.

FIG 5.
Filler Mouth-Lamp and Cabinet

28. Browning Mouth-Lamp.—The Browning Manufacturing Company supplies a mouth-lamp to be operated by a battery giving from 4 to 10 volts The lamp is enclosed in an aluminum shield, and, inasmuch as this lamp is not to be used as on a commercial current, the metal shield will not endanger the patient.

A cautery and root-drier, also shown in Fig 8, are interchangeable with the mouth-lamp.

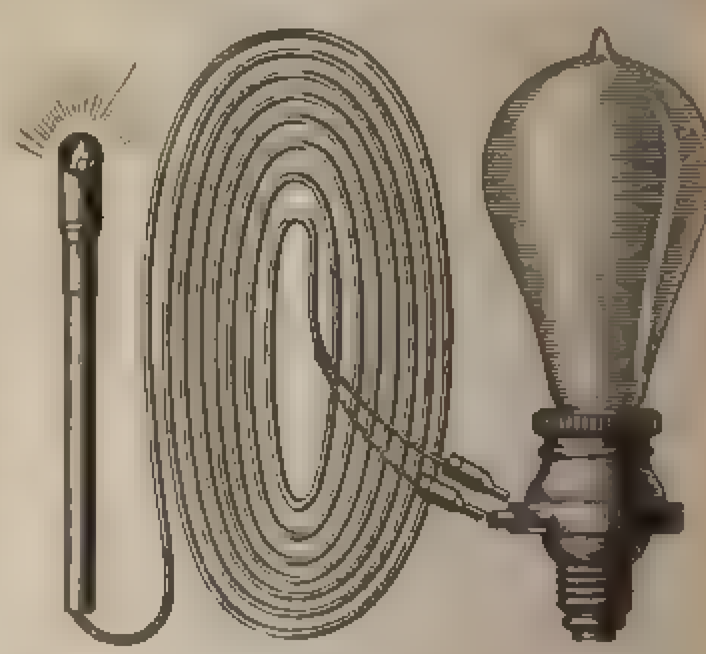

FIG 6.
Victor Mouth Lamp for Use Upon the Commercial Current

29. Garhart Mouth-Lamp.—The Garhart Dental Manufacturing Company manufactures a neat little mouth-lamp, the invention of Mr. E. E. Werner, which is to be used interchangeably with their cautery, as shown in Fig 9. This is designed to be operated on any commercial current used for lighting. The connecting-cord,

which conducts the current to the lamp, contains a fine

FIG. 7
Victor Lamp Operated by Battery

FIG. 9.
Garhart Mouth Lamp.

FIG. 8.
Browning Mouth Lamp

resistance wire that acts in a twofold manner: While it conducts the current, it at the same time gives the proper resistance to cut the current down to the proper strength for the lamp, thus overcoming the necessity of a separate resistance-block.

The special feature of encasing a suitable resistance in the conduction-cord itself is novel, and a most satisfactory method of introducing the necessary resistance when operating small lamps upon commercial circuits.

30. Current-Strength to Operate Lamps.—The dentist can easily make his own mouth-lamp if he so desires. In selecting a miniature

lamp from a catalogue for the purpose of making one, if a 1-candlepower lamp is desired and it is to be used in series with a 32-candlepower lamp on the 110-volt current, then the mouth-lamp should be rated to consume 1 ampere, for the reason that the large lamp, which is used for resistance, allows that much current to flow, and the additional length of filament in the small lamp will cause no appreciable diminution of current. If the small lamp should be rated to consume ½ ampere of current, then a 16-candlepower lamp will give the proper resistance on the 110-volt current. If the small lamp is to be used on the 55-volt current, then the resistance lamp should be one-half the above candlepower, for it should be borne in mind that as the voltage of lamps of rated candlepower decreases, the amperage rises. A 16-candlepower lamp, for instance, requires about ½ ampere at 110 volts, or 1 ampere at 55 volts.

31. Electric Bicycle Lamp as a Mouth-Lamp. The electric bicycle lamp makes a splendid mouth-lamp when properly mounted in a handle. This may be operated by the battery that is sold with it; or a 32-candlepower, 110-volt lamp usually gives the proper resistance when used on the 110-volt current. A black-rubber tube should have a hood vulcanized upon one end of it at an angle of about 30°. This hood should be large enough to enclose one-half the lamp. If the hood be lined with a thin layer of plaster of Paris, it will both reflect the light and serve as a non-conductor.

32. Perfect Insulation of Mouth-Lamp.—When any mouth-lamp is to be used upon a commercial current, the operator should be assured as to the insulation of the lamp. It should be incased in a vulcanite handle in which no metal parts are exposed, for it is an easy matter to obtain a ground through the water-pipes or gas-pipes, especially where a cuspidor is attached to the chair. The dentist himself can often convey a painful shock to the patient when using a commercial current without himself being aware of it, except by the patient's behavior. The mucous membrane of the mouth

is extremely sensitive to electric currents, and by reason of its moisture is always ready to make a contact. Where a fountain cuspidor is fastened to the chair a ground can be established if by nothing else than the column of water in the rubber tube. When operating a foot-switch with damp shoes, an accidental grounding will be sure to be felt by the patient. It is therefore important to see that the insulation of the mouth-lamp, and, indeed, of all electrical instruments used about the mouth, is of the very best. As a matter of security from any such accidents a fiber insulation should be inserted between the fountain cuspidor and the metal work of the chair.

HEAT.

INTRODUCTION.

33. Value of Heat.—In taking up the subject of electrical heat, we are dealing with one that has a greater variety of applications in dentistry than any other electrical phenomenon. We are also entering a field in which, if we consider the importance of the operations performed, and the value of electricity in the part that it plays in these operations, it is unequaled in any art or science. We are considering an agent that, on the one hand, will give results so accurate and so delicate as to meet the most exacting of dental requirements, and on the other hand an agent that will give the greatest heat that it is possible for man to obtain. It is, indeed, wonderful when we consider that a wire scarcely larger than a thread can convey to the operating table a current so delicately measured out as to anesthetize sensitive dentin, or to warm a tube for the dessication of dentin, and it is still more wonderful when we consider that along this same wire may flow enough current to melt platinum, or to fuse a porcelain plate.

34. In considering the useful applications that can be made of electrical heat in dentistry, we find that, at the present time, there are no less than a dozen, and two of these applications are of the greatest importance. For years dentists have been using impure and uncertain heat for annealing gold

and for fusing porcelain, but, with the advent of commercial electricity, an agent is found that, it would seem, was especially designed for these two processes. While the other dental uses that are made of electrical heat are not of the high importance of the two just mentioned, the matter of cleanliness, simplicity, and accuracy of operation are properties that recommend its adoption in dental practice.

35. Production of Electrical Heat.—The production of heat by electricity depends on two factors—the quantity or the ampere-strength of the current flowing, and the resistance of the conducting agent. As the quantity is increased the heating power is also increased, but this power is not apparent until the current meets with some resistance. The unobstructed flow of any quantity of the fluid does not produce heat. It is only when there is placed in the circuit a poor conductor of electricity that we have this manifestation. All metals are comparatively good conductors of electricity, yet these vary in their conducting power. Silver stands at one extreme and bismuth at the other. Between these two stand all the common metals. Copper is next to silver in conductive property, and by reason of its comparative cheapness, is used for commercial wiring for electricity. It carries the current with but little loss in wasteful resistance. For other purposes, as, for instance, the cautery, electric gold annealer, and oven, the wire must possess both resistance and a high melting-point, and platinum meets these requirements best.

36. Resistance of Conductor.—The second factor that enters into electrical resistance is the cross-section of the conductor. With a given length of wire the resistance increases as the diameter of the wire decreases. That is, a small wire has less carrying capacity than a large one, so that when the same amount of current that may be easily conducted by a large wire is forced through a small one, the condensation, we will term it, produces heat. We therefore see that with the same quantity of electricity at a given pressure, heat is produced according to the resistance of the conducting agent.

THE ELECTRIC GOLD ANNEALER.

ANNEALING.

37. Present Method of Operation.—In *annealing gold*, as this daily performance is erroneously called, it is customary to pass the gold through an alcohol or gas flame, until it assumes more or less of a red heat. The object of this procedure is not to anneal the gold, for that was done by the manufacturer, but to drive off the gases that are condensed upon the surface, or, perhaps, are occluded within it, the principal of which is ammonia. This operation is usually performed by the dentist picking up a piece of gold with a pair of tweezers and passing it through the flame of a lamp. And it is a common practice, even in dental clinics by dentists of high reputation, to use a pair of foil tweezers whose points are as large as the pellet itself. They grasp the gold with these points, covering at least one-third of the pellet, and then pass it back and forth through the flame until the edges begin to melt and fuse together. It is necessary to do this in order that the part between the tweezer points be brought to the proper heat. Or, if the free edges of the pellet are properly annealed, that part between the tweezers cannot possibly be. Yet, such a piece of gold, even in a half-annealed condition, or with its edges a fused mass, will be cohesive enough to adhere for the time being. Later on, however, such a filling will flake off, and especially if any strain is brought to bear upon it. The strongest fillings are those in which each layer of gold is fully annealed without at the same time fusing the edges into a thick rim.

38. Objections to the Flame for Annealing Gold. It might be stated without error that, while it is possible to perfectly anneal a pellet over a flame, by taking it up twice in the pliers, having turned it end for end, that is not the practice. The nearest approach of the best operators to this is by using the most delicate tweezers obtainable, and holding the pellet of gold above the flame at such a height that the heat is

broadly and evenly distributed, and until it is brought to a dull-red color throughout. This requires time and the utmost care. It is said that a chain is no stronger than its weakest link, and so it is with a gold filling; it is no stronger than the most defective piece of annealed gold in the contour. A single piece of carelessly annealed gold will be fatal to a contour, even if every other piece has been perfectly annealed.

The second objection to the flame for annealing is the small area of the heat and the inequality of the same. If each piece is to be properly annealed, the greatest care must be given to each annealing. This requires an amount of time that is no small factor in the operation.

The third objection to the flame is the liability to contaminate the gold with the unconsumed gases or the by-products of combustion. If the gold were to be carelessly introduced in the lower part of the flame, it would be subjected to the influence of the vaporized alcohol; or if it were to be placed in the upper part it would be coated to a certain extent with the products of combustion. In spite of these two faults of flame annealing, the gold will, however, be made sufficiently cohesive to answer all purposes so far as the building up of the filling is concerned. It will not be, however, until a strain is brought upon the gold that the defects produced by the impurities of the flame show themselves.

Fillings that are built up of gas-contaminated gold show a tendency toward disintegration throughout, while a filling made up of cleanly annealed gold, but with an occasional piece over- or under-annealed, will flake off in large pieces, or perhaps a whole contour will come off in one piece.

39. Causes of Insufficient Annealing.—It is true that perfect fillings have been made ever since the discovery of the cohesive property of gold, but these have been made only by the most careful and accurate methods of annealing, methods that have become a habit to the operator. On the other hand, the failure of nearly every filling by the loss of the contour, or by the flaking from a plain surface, is due to bad annealing. Many an operator lays the blame for these things, and the

harshness, as it is sometimes called, upon the gold, and its manufacturer, when, as a matter of fact, the fault was all his own. He failed to perceive that he was melting the gold upon one edge, and not annealing it at the other, so that any kind of malleting, however thorough, could never bring these pieces into a thoroughly cohesive contact of sufficient strength for ordinary service.

40. Time Required for Annealing.—The amount of time consumed in annealing by the old process is a considerable

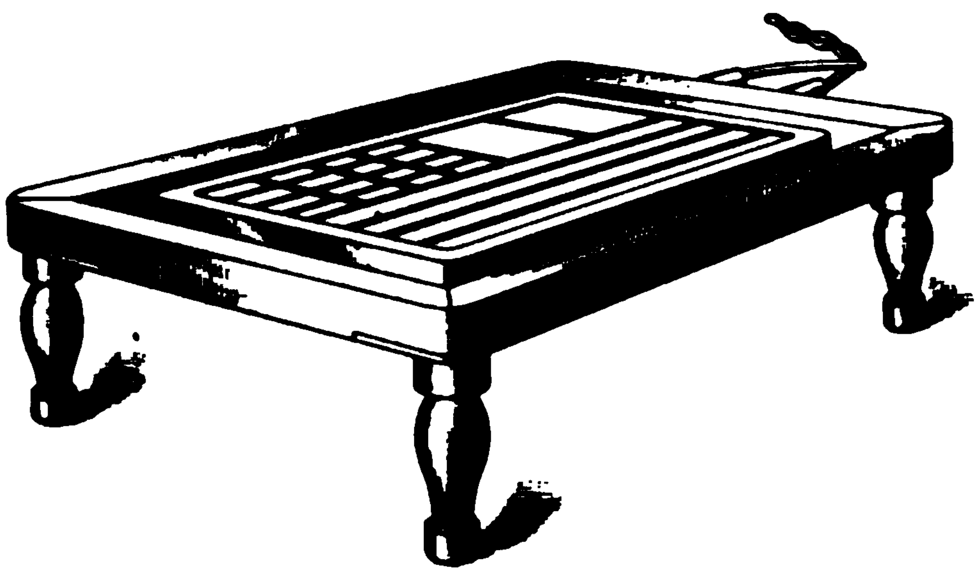

FIG. 10.
Custer Electric Annealer.

part of the operation, especially if the amount of care is observed that the importance of this step calls for. If this work is not done by an assistant, it necessitates changing the plugger for pliers and back again for each piece of gold, as well as the time consumed in the annealing proper.

41. Description of Electric Annealer.—In order to overcome these common faults of the flame annealing of gold, the electric annealer was invented. This consists of a tray of vitrified fire-clay through which are distributed fine wires of platinum by which the tray is heated. The tray is mounted in a mahogany frame, the purpose of which is to act as a rest upon which to steady the hand while taking up the gold. The wire is so proportioned as to take up the full pressure of the current and to produce heat enough to develop the highest cohesiveness of the heaviest foils. If, however, less heat is desired for annealing the De Trey gold, or to develop only semi-cohesiveness for cervical portions of the cavity; or, if a very little heat is

desired for softening gutta-percha upon the cover that accompanies the annealer, an enamel rheostat, such as is used for regulating the dental engine, or that can be had of the Ward-Leonard Company, of New York, will reduce the heat to any desired degree.

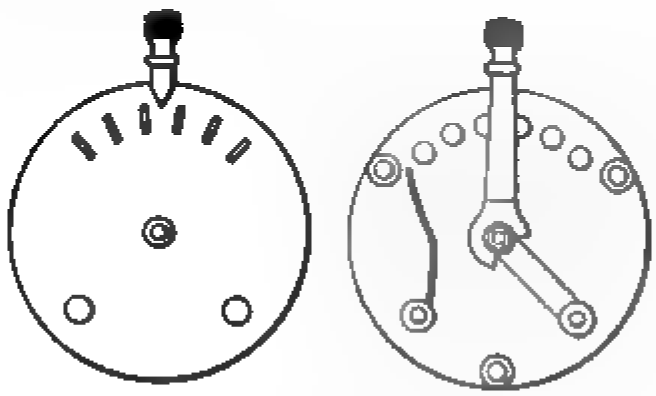

FIG. 11.
Ward-Leonard Rheostat

The rheostat is usually of $\frac{1}{8}$-horsepower capacity, and it will be found of service for regulating other dental instruments as well.

The annealer is wound for all voltages up to 220, and can be used on either the direct or alternating current. In a general way it may be stated that the instrument can be used on any current used for incandescent lighting.

42. Advantages of Electric Annealer.—The advantages of the electric gold annealer are many and of considerable value. Probably the most important feature is the purity of the heat. This is derived from a platinum wire that is electrically heated. Platinum itself is a noble metal, it is not oxidized by the heat, and emits neither vapor nor odor. Platinum is the chemist's indestructible material. The wire being electrically heated, there is a complete absence of any gases, either consumed or unconsumed. The heat of the electric gold annealer is absolutely free from the products of combustion. It is a radiated heat, and, being radiated from a noble metal, is absolutely pure. When gold is annealed on an electric annealer it is put into a condition of absolute purity. It is customary in the practical use of the annealer to allow the gold to remain on the tray for some time, which insures the complete driving off of the contaminating gases.

43. Arrangement of Wires.—The second feature of importance is the even annealing of the gold. The tray is so wired that a perfectly even heat is maintained all over the surface. It is not generally known that an equal distribution of

wire in electrical heating, even in an enclosed cavity, will not produce an even heat in the oven cavity. There is a tendency of the heat to accumulate in the center, and to overcome this defect a system of wiring was devised whereby a perfectly even heat can be obtained in electrical heating surfaces that are not true spheres in shape. This system is used in both the annealer and electrical oven. The annealer is so constructed as to present a system in which the wires are arranged in a geometrically decreasing distance apart as they are distant from the center of the tray. In this manner the wires in the outer edges of the tray liberate much more heat than in the center, but the circulation of the heat from without, inwards, compensates for the lesser radiation of heat in the middle of the tray. The result of this method of wiring is a perfectly even heat on all parts of the tray, so that no matter where the gold is placed on the tray it will receive the same degree of heat.

44. Thorough Annealing of the Gold.—The third feature is the thorough annealing throughout the pellet. It is customary in using the electric annealer to prepare the gold upon the tray before adjusting the rubber, and about 2 minutes before the gold will be required the current is turned on. The heat quickly rises and the pellet at the same time is heating up so that by the time it is to be used, it has the same temperature throughout, and the gases have had time to escape. After this the gold remains the same for hours; in fact, as long as the current is flowing in the annealer.

45. Temperature Required.—The annealer is so carefully wired for the respective current for which it is intended that the heat rises only a little beyond the limit at which the highest cohesiveness is developed, or about 400° F. When gold is annealed over a lamp it is frequently customary to bring it to a cherry-red. This is not necessary for the part of gold that assumes that color, but for the part between the tweezer points The cohesive property of ordinary gold-foil shows itself at about 250° F., and this cohesiveness is increased from that point up to about 375° F., after which nothing is gained. This heat is not high enough to become visible, and many

dentists upon observing it, would be of the impression that the gold could not be thoroughly annealed, but clinical use of it shows it to be most highly cohesive. Moreover, the heat not being excessive, the gold may be subject to it for hours at a time, and not be injured in the least thereby. For this reason no special care need be exercised in the preparation of just enough gold for a particular cavity, as any remaining gold can be covered up and used equally well for the next filling.

46. Economy of Time and Expense.—The last feature to deserve attention is the economy of time and expense in operating it. The surface of the tray is of hard-baked fire-clay, which is naturally rough, and as a further aid the surface is ribbed. The object of this is to prevent the pieces of gold jarring together, and also to aid in picking them up. The operator in a short time acquires the practice of picking the gold from the tray with the same plugger point that he is using. This can be so dexterously done that the temper of even the smallest point will not be injured thereby. This saves a vast amount of time, as compared with the method of picking up the gold with tweezers and exchanging instruments both ways in so doing. Moreover, the time consumed in passing through the flame is entirely done away with. The expense of operating the electric annealer is very much less than that of an alcohol-lamp, so that also in the point of economy in operation, the electric annealer has the advantage.

THE ELECTRIC OVEN.

47. Electric Oven for Fusing Porcelain.—Perhaps of all the applications of electric energy in dental practice, no one is so important as that of fusing porcelain. It solves the difficulties that have attended porcelain work from the beginning. The invention of the electric oven marks the beginning of modern porcelain work in dentistry, and it was immediately adopted by the profession for reasons that are obvious. There was not, up to that time, an absolutely certain method of fusing porcelain. With the appliances then in use it was a matter of considerable guesswork, and even the most skilled always

worked with more or less misgivings, which gradually changed into a state of continual anxiety, as the case neared completion. The electric oven was invented by Dr. L. E. Custer in 1894.

48. Superiority of Electrically-Heated Oven.—Gas and oil furnaces had been devised for porcelain work, but while they were more easily operated and consumed less space and fuel, they never produced the clearness of results that characterized a piece properly baked in an anthracite-coal oven, so that the prosthetic dentist was ready to accept the new invention with some enthusiasm.

The electric oven made the fusing of porcelain such a simple process that there was a revival of interest in this work, and it may be said to be the foundation and beginning of modern porcelain art. Up to the time of the invention of the electric oven, porcelain work, and especially the construction of full cases, was carried on by a few that were specialists in that line. The many difficulties and uncertainties attending the heat made porcelain work a formidable method of practice. The first ovens were large and dirty affairs. This was true to such an extent that the oven was usually placed in the cellar of the house or in an out-building. These ovens were frequently as large as an ordinary bookcase, so that the space occupied was no small consideration.

49. Objections to the Old-Style Oven.—The principal objection to this style of oven was the time consumed in obtaining a heat into which it was suitable to introduce the porcelain. Since porcelain is easily affected by gases of any kind, which would find their way through the walls of the muffle, it is necessary in the use of this kind of an oven to completely burn them off before introducing it. For this reason, the fire must burn for some hours before it is safe to begin the fusing of porcelain. In the meantime the apartment itself is becoming so uncomfortably warm that the dentist finds himself in no condition to see patients, nor is it allowable for him to do so at this time. As a matter of fact, he must shut himself up with the oven until his case is finally finished,

the inconvenience of which is recognized only by the older practitioners.

In baking a piece of continuous gum in one of these, there were always so many uncertainties that the dentist was uneasy from the beginning to the end. The muffle in which the cases are baked would sometimes break and ruin the whole piece. The occasional gassing of a piece, the movement of the teeth by the jar of introducing or removing a case when putting it into the annealing oven, as must be done when using these ovens, were but minor troubles attending these old forms.

50. Observing Fusing Process by Old Method.—The difficulty of observing the fusing process was always present, and yet the experienced dentist did this wonderfully well. He was contending with a large volume of heat and his piece being heated to the same degree, made its observation a difficult matter. It was even hard to make out the piece, much less tell the exact state of fusion. Experience, however, taught him to gage the general heat with the eye, which was generally well done, considering the difficulties. The artful one, however, in some cases would introduce a cold iron rod over the plates, which would cast a shadow thereon and aid in telling the degree of fusion in that way.

51. Regulation of Temperature in Coal Ovens. A case fused in this form of oven must be slowly introduced. It is in this way that its heat is gradually raised. The dentist here deals with a fixed heat, and his only method of increasing or decreasing the heat of his plate is to slowly introduce it into the oven, and when the case is fused he must carefully remove the same to an annealing muffle, where it is allowed to cool slowly. How different is the electric oven, where a touch of the button does it all.

52. Uncertainties of Coal, Gas, and Oil Furnaces. Not only is the fusing of a continuous gum case in a coal oven fraught with difficulties and uncertainties, but the whole process is one that keeps the dentist in a state of anxiety from beginning to end.

The gas and oil furnaces that were put upon the market out of the demand for a simpler and cleaner method for fusing porcelain, and while they were smaller, cleaner, and perhaps more economical in their operation, did not meet the most exact requirements of the continuous gum worker, in that they did not produce a perfectly clean and pure heat; moreover, by a contrary nature of things, those that did produce a reliably clean heat did not give one high enough for fusing the higher fusing porcelains.

53. Construction of Electrical Oven.—The form of the oven was a departure from the usual muffle-shaped ovens. This was for the reason that we were no longer dealing with heat derived from a flame or a bed of coals in the midst of which the baking was always done. In the construction of the electric oven, the heat is generated in the walls of the muffle, and the walls are given a shape to conform to the outline of the piece treated, for the important purpose of producing an even heat for the case, and for economy. This was a radical departure from other ovens, and it took some time before it was fully comprehended that it was in keeping with the conditions met with in the new methods of heating In the old method for full cases it was customary to manipulate the case in the presence of the heat, whereas, in the new it is the method to manipulate the heat, and it is not necessary to move the case from the beginning to the end. For this reason the oven may be made of a form and just large enough to contain the case. For electrical considerations, it is divided into two halves, the wiring of each of which, in the full-case size, is an exact duplicate of the other. In the crown and bridge size, the line of division, for the sake of convenience, is placed flush with the bottom so as to present a plain surface which facilitates the placing of the most delicately constructed crown or bridge. In this the wiring of the top of the upper half is a duplicate of the floor, and the wiring of the side walls is perpendicularly arranged.

54. Manipulation of Electrical Oven.—It was difficult for the older practitioners to fully realize that in the baking of

a piece in an electric oven, it was so simple a process as placing the piece in the oven, turning on the current until it was fused, and leaving the piece in the oven to cool and temper They held the belief that it should be placed in a muffle to cool. To meet this idea some of the ovens are cut down in front so as to facilitate the removal of the piece. The heat goes down so quickly after turning off the current that there is no danger

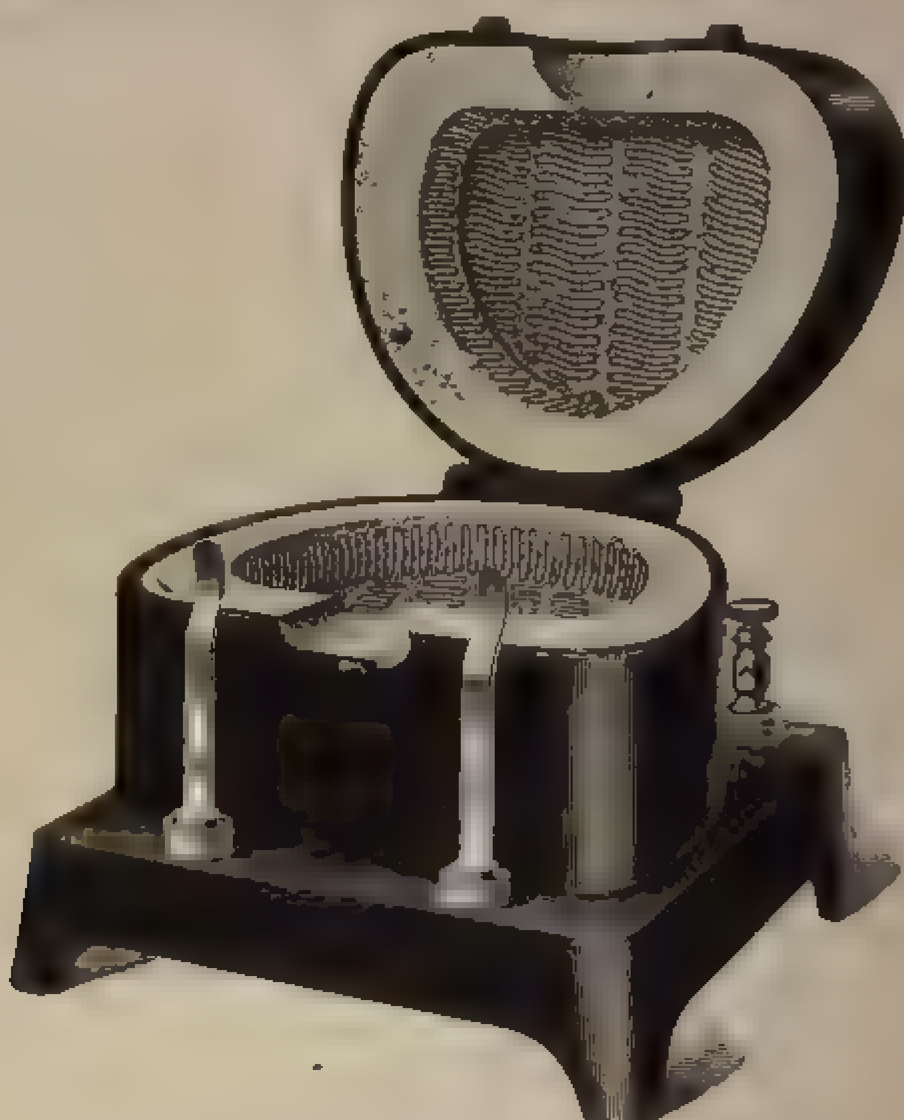

FIG 12.
Custer Electric Oven for Full Cases.

of overfusing and no necessity for removing the case. Moreover, the claim is made that the oven itself is the best annealing oven that can be had, and that a piece which is allowed to remain in the oven until cool will be of much finer temper than one that has been removed to an annealing oven. For this reason the oven recommended for the most satisfactory

results is the form illustrated in Fig. 12. Its wiring is simple, and the front and rear openings are in the best possible positions for observing the case. The outer casing is of iron, which has inwardly projecting lugs for holding the clay lining. The heating cavity is large enough to comfortably contain a set of teeth. The walls of this are of non-vitrifying fire-clay, about $\frac{3}{8}$ inch in thickness around the sides and top. The bottom is somewhat thicker for obvious reasons. In the inner surface of the clay walls are imbedded the wires that are electrically heated and that are the essential part of the oven. It is to these features that we shall give especial attention.

55. Temperature of Oven.—The first thing to be borne in mind is that the melting-point of the heat-giving wire is but little higher than the porcelain that is to be fused, and yet it is within this narrow margin that we are working. It is therefore important to take advantage of all the conditions that will tend to secure the fullest and most rapid effect of the heating agent upon the object treated. In other words, the closer we can bring the porcelain to unobstructed heat-radiating wires, the less heat will be required of the wires, and the margin between that and their fusing-point will be greatest, and in proportion as we remove the object from the source of heat, or introduce an obstructing partition must the heat of the wires be raised. It is the taking advantage of all the conditions that favor the effective application and conservation of the heat, and the carrying out of the wiring in its finest details, that makes the electric oven a practical instrument.

56. Exposed Wires.—In the electric oven, the wires are laid in the surface itself, the aim being to invest them only deep enough to support them while so highly heated. In putting the first ovens upon the market, it was necessary to cover the wires with a thin layer of clay for the purpose of protecting them from metals and other substances that the experimenting dentist would introduce. But later on, as the dentists learned the peculiarities of the electric oven, they were sent out with the wires fully exposed. In so doing, an important point is obtained, for the introduction of anything

between the wire and the porcelain necessitates a higher heat of the wire than would be necessary were nothing intervening. The wire is imbedded just deep enough in the clay to be caught. It matters little how much they may become exposed by use, so long as they do not buckle to the extent of touching neighboring wires, no harm will be done. As a matter of fact, the more the wires free themselves from the clay the more efficient the oven will become, and the less will be the strain of heat upon them. It will be seen, then, that the introduction of an intervening wall or the winding of the wire around the outside of a muffle of clay with the intention of fusing a piece within, will require the wire to be heated to a much higher degree, to produce an equal result within.

57. Distance of Wires from Porcelain.—The second feature is that the heating wires of this oven are the shortest practical distance from the piece to be fused. The farther the wires are placed from the porcelain the higher must be the heat of the wires to produce the same result. When a wall is introduced between the two, the obstruction not only causes loss of heat by conduction, but it necessitates the removal of the wires from the piece just the thickness of the wall farther than they would otherwise be Hence, an oven with a wall of clay between the wire and the porcelain demands an additional difference of temperature between the two, for the reason that the fusing-point of the porcelain always remaining the same, it is necessary that the heat of the wire should rise still nearer its melting-point to compensate for the non-conduction of the partition, and over and above this, the additional resistance by the partition itself. So it will be seen that a wall does two things: it interposes a non-conductor, and it removes the source of heat from the object treated.

58. Advantageous Wiring of the Oven.—The third, and most important feature of the electric oven is the complete covering of all the walls with heat-radiating wires. Since the heat of the oven comes from the wires, it is evident that the more wires there are for radiating the heat, the less will be

required of the individual wire. For this reason, the wires are not only arranged as closely together as it is possible to arrange them, but all the walls are completely covered and are heat-producing surfaces. If, for instance, a cavity were to be raised to a certain heat, two wires might do this very easily, but one wire doing it must be much hotter than either of the two And so it is with the electric oven. If one of the side walls were blank, or if, as in some ovens in which both ends are not heat-producing surfaces, it is necessary for those walls that do produce heat to be raised to a much higher degree than would be otherwise required, in order to make up for those walls that do not radiate heat. This means an overheating of the wires and an early failure of the ovens from crystallization, which appears to take place in overheated wires. While the covering of all the walls with wires is a most essential point for the longevity of the wiring, it is also important, in fact, necessary, for producing an even fuse in a full set of continuous gum. A muffle-shaped oven, with only the side walls heat-producing surfaces, and the ends blank surfaces, cannot produce an even fuse of a full set of continuous gum unless it is very large. In fact, it must be large enough in diameter and long enough to take in at least three sets of teeth to insure perfectly even fusing of one full set of teeth, when placed in the middle. This is not as they are found on the market. There is scarcely more room than is necessary to close the door. A case can be fused in these ovens it is true, but it is usually necessary to bring the case to a very high fuse on the sides to insure sufficient fusing of the ends. This is very clearly seen in a half-fused case, but when the heat is carried higher until all parts are fused, it becomes a difficult matter to detect by the eye over-fused from properly fused Only the test of usage tells an unevenly fused plate.

59. Even Heat.—The fourth feature of this oven, which we may say is also important, because it has to do with the wiring, is the arrangement of the wires to produce an even heat. In practice it was soon found that there was a tendency of the heat to accumulate in the center. It was found that in all cavities not purely spherical in shape, if wound with wires the

same distance apart, the long diameters would not become as hot as the short diameters. In order to remedy this and to produce an even heat, beginning at the points most distant from the center, they were wound as closely together as they could be arranged without touching laterally, and as the center was approached the distance between them was increased. The exact distance was only arrived at experimentally, and it was finally found that there would be required about three times the amount of wire in a given area in the most distant point of a Custer oven, that would be necessary in the center. The effect of winding any oven with wires equally distant on all the heat-producing surface is obvious. It means two things: first, the wires in the center become overheated by the accumulation of heat; and, second, the porcelain is unevenly fused.

60. Temperatures at Ends of Wires.—The fifth detail was an improvement in the wiring, arrived at, only after the study of the working of many ovens. It was not generally known, if known at all, that the negative end of a wire, when heated by a constant current, becomes about one-fifth hotter than the positive end. As yet there has been no satisfactory explanation of this phenomenon. The unequal heating does not become apparent in a wire heated in the air, but it is present in the electric oven, and accounts for the trouble that arose at the negative end. It was found that the burn-out always occurred at this end of the wire because of its over-heating. This trouble was quickly overcome by using a wire that was a gradual taper from one end to the other with the larger end at the negative. In making the negative end one-fifth larger in cross-section than the positive end, the wire will be heated the same throughout, and such an oven will not burn out when properly used. It is obvious that while this method of wiring is an essential point when the oven is used on a constant current, the conditions will be just the reverse if the current should be connected in the wrong manner, with the negative to the positive.

61. Keeping Wires in Place.—The foregoing are the essential points in the electric oven. They are the ones, the

observation of which makes it a possible and practical instrument for fusing porcelain. In addition to these features there are two others of which it will be well to speak; one being the detail of the wiring, whereby they are kept in place, and the other some means to facilitate the observing of the case while it is fusing.

While platinum and the fire-clay expand and contract much alike, there is still a little difference. To meet this the wires are arranged so as to form a continual curve from beginning to end, a section of which is illustrated in Fig. 13.

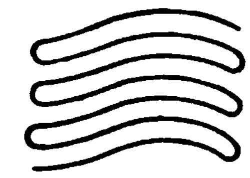

FIG. 13.
Section of Wiring.

Placed in this manner, movement takes place in very small segments of an arc, and there is no tendency of the wires to break from their investment.

62. Observing the Fusing of Porcelain.—The other feature is the use of two small openings for observing the fusing of the porcelain. The heat of the electric oven is so intense and the light is so bright and even, that it is difficult to clearly make out the fusing of the porcelain. To overcome this difficulty, two openings are made, a small one in the top for the admission of a ray of different colored light from without, and a larger one in front for observation. The rays of light entering at the upper opening are reflected by the plate through the front opening. This brings out the process so clearly that even the inexperienced can see and understand the fusing as it progresses. While it was originally intended to use sunlight through the small opening, the uncertainty of obtaining a light from this source at all times led to the invention of an arc-light for this purpose, as shown in Fig. 14.

When the porcelain has about reached the fusing-point and the lever is on the last button of the rheostat, the operator strikes a small electric arc in front of the upper small opening, which shines down in the cavity upon the plate. The observer from the front can now see with as much distinctness as if the oven were open, and can easily tell just how far the fusing has progressed. This feature alone is a most pleasing one, for while the dentist can time his oven much as he would a

vulcanizer, he cannot be certain of getting precisely the same fuse every time. The use of the arc-light makes him independent of any mechanical appliance and gives him an opportunity for modifying the fusing to suit his most critical taste.

63. Purity of Heat.—The advantages of the electric oven are many. It is the ideal method of fusing porcelain. The heat being derived from an electrically heated platinum

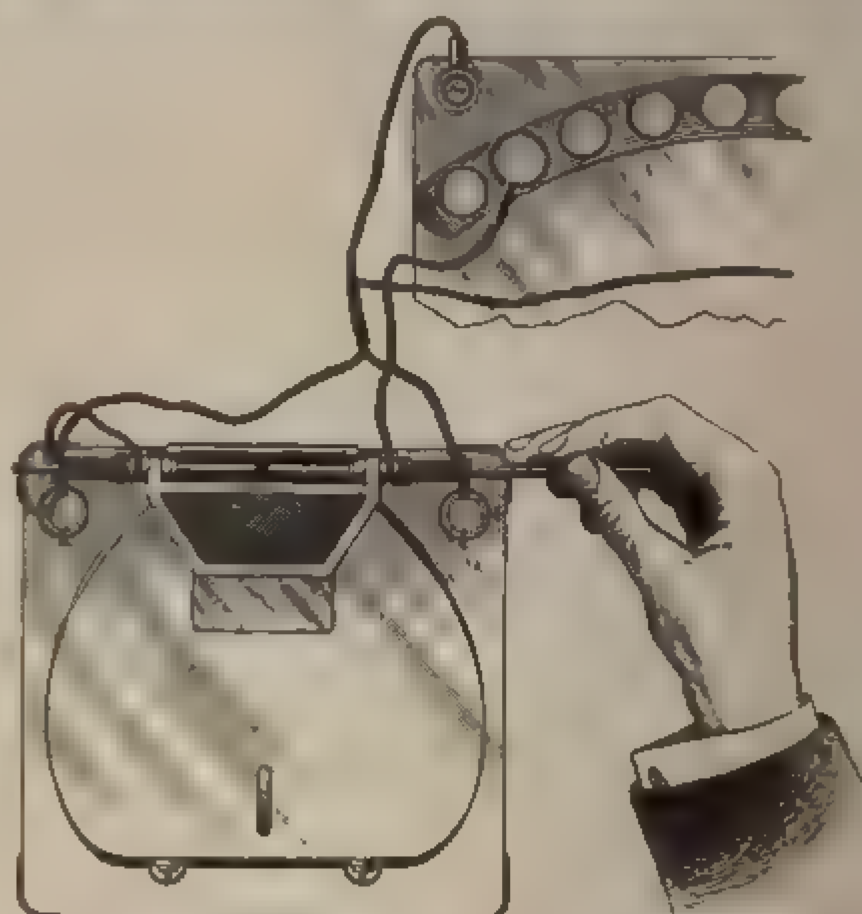

FIG. 14.
Custer Arc-Light

wire, its purity is insured. The ever-present liability of gassing, in the older forms of ovens, is overcome at once by the electric oven, for it does not operate by the combustion of anything. Its heat is a radiated one and that from a noble metal that does not oxidize. The first and most important requirement is for this reason most perfectly met.

64. Intensity of Heat in Fusing Porcelain.—The second requirement is the intensity of heat. Since platinum is the radiating metal, its fusing-point is also the limit of the heat

This, fortunately, is somewhat higher than any legitimate use for which porcelain fusing calls, and, as a matter of fact, the electric oven under intelligent management will give a greater heat than any other incandescent oven in use. The tooth-carving bodies, which have the highest requirements for heat in dentistry, can be fused in the electric oven, the only requirement being that the piece be watched and the current turned off when the pieces are fused.

65. Necessity of a Rheostat.—The ease with which the electric oven can be controlled by means of the rheostat puts it under the absolute control of the operator. Some manufacturers, as a selling dodge, advertise that a rheostat is not needed with their oven. It is not necessary to use a rheostat with any oven for that matter. It is not essential to the oven, but it is a convenience that a wise dentist will not be without, and especially when fusing a full case. The rheostat, like a gas-valve, is the means by which the heat is raised or lowered to suit the operator. When a piece is fused in an oven without a rheostat, the heat rises at a rate that he cannot control in any way.

The practical method of fusing porcelain pieces, as it is generally performed, is to give it a length of time somewhat proportionate to the size of the piece. A single crown can be fused in 12 minutes from the cold oven, but a full case should not be fused in less than 30 minutes, beginning with a cold oven. This cannot be done except by the use of a rheostat. The fact that most operators who buy a cheap oven afterwards buy a rheostat, is evidence that the rheostat is a valuable adjunct. When the rheostat is used the dentist has absolute control of his oven, and the amount of time that it saves will pay for the investment in a short time. Moreover he can do with it something that cannot be accomplished in any other way. He can slowly approach the fusing heat and then throw on the full heat with a suddenness that brings out the color of the gum in its most brilliant hue.

The life of many pieces of porcelain is destroyed by keeping them too long near the fusing-point. When the rheostat is not

used there is a long drawn out heating below the fusing-point, during which time the color of the pink gum fades. If this stage can be quickly passed over, as it can be by the use of the rheostat, the life of the gum will be preserved.

66. Size of Electric Oven.—The size of the electric oven is smaller than any other. It is scarcely larger than an ordinary dental flask, and for that reason can be used in the operating-room as well as in the laboratory. It requires no connection of rubber tubes, bellows, and the like, but in their stead a flexible cord and plug to be screwed in the nearest electrical bracket.

67. Cleanliness of Oven.—The cleanliness of the oven makes it in keeping with the other appointments of the dental office. More and more the operative dentist finds use for porcelain operations, and the cleanliness of the oven allows of its being used in the operating-room. It is without gas, noise, odor, or dirt, features that should be preserved in the dental office as far as possible. The electric oven, in these respects, is a fair illustration of the fitness of electricity in dental practice. It comes in through the conductors quietly and subtly; a horsepower of current may be in operation and we are unaware of its presence except for the visible exhibition of heat.

68. Expense of Electrical Heat.—Electrical heat, all things considered, costs no more than, if as much as, the other processes of fusing porcelain. The reason for this is the economy of heat. In the electric oven there is the most complete utilization of the heat, but the smallest part being lost by radiation; whereas in the older forms of ovens only the smallest part was utilized in fusing the porcelain. To fuse a set of teeth takes an amount of fuel in the coke ovens sufficient to heat a house of ordinary size a whole day, whereas the electric oven will not heat in the same way the tenth part of a room for half that time. While electric heat is much more expensive than that derived directly from coal, the comparatively small amount of electricity consumed in the fusing of a set of teeth makes it very economical.

69. Manipulation of Rheostat.—The electric oven, finally, saves considerable time In fusing a set of teeth the rheostat is put upon the first button, where it is allowed to remain until the case is thoroughly dried out. The dentist may be making a gold filling in the meantime. When he is satisfied that the case is dry, he can throw the lever over two or three buttons at a time, according to the length of the previous interval. This is repeated at his convenience until the third from the last button is reached, upon which he will allow the lever to stand until he can give the case his undivided attention for 3 or 4 minutes. When he is ready he will turn the current on full at once, and, the oven and case being thoroughly heated, the case quickly drops into a fuse and the operation is finished; the whole process of fusing a full case occupies but a few minutes of his time. And yet he is present at the critical period of the fusing process.

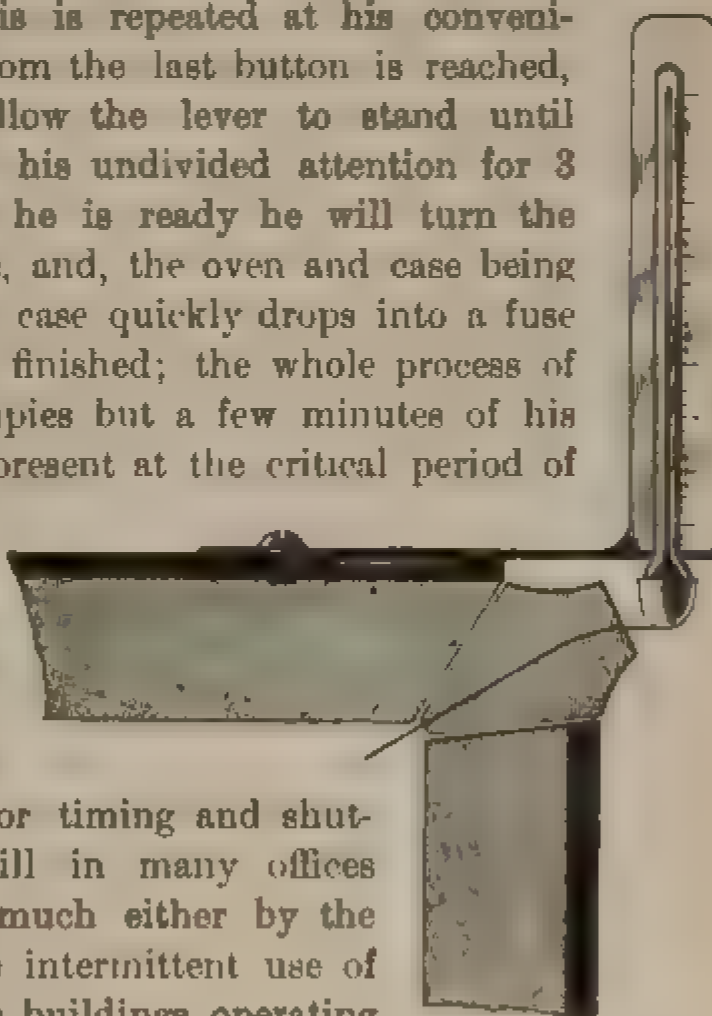

Fig. 15.
Thermometer for Electric Oven

70. Thermometer for Electric Oven.—While it is possible to use an ordinary alarm-clock for timing and shutting off the oven, still in many offices the voltage varies so much either by the time of day or by the intermittent use of it in large quantities in buildings operating elevators thereby, that this is not a reliable thing to do. However, in those offices in which, by trial, the current has been found to be without much variation, timing the case will be entirely feasible, and reliable results will be had

A method devised by Dr. J. R. Callahan for use with the oven, deserves notice. Doctor Callahan uses a high-reading thermometer, placing the bulb of the same in a clay stopper molded to fit the upper opening. This very accurately measures the heat of the oven, especially if the fusing is

always started from a cold oven. If, however, the oven is hot at the time of beginning a fuse, the thermometer will read a little higher by reason of the casing being heated at the beginning.

To overcome this objection to Doctor Callahan's method, a platinum wire is loosely embedded in the clay stopper, one end of which projects in the oven cavity and the other terminates in a cup, which receives the bulb of the thermometer. One known as the "pastry" thermometer is used for this purpose. This is about 6 inches long and reads to 600° F., the whole appliance being shown in Fig. 15.

By using the wire the heat is conducted from the oven cavity more sensitively than by the clay stopper, and the heat of the cup, while not as great as that of the oven, is always exactly proportionate to it, and a scale having once been made can always be depended on thereafter. If it is desired to be absolutely accurate in the fuse, it can be done by using a pellet of gold, which can be seen to melt, as the basis of calculation. It is only necessary to turn off the current when the mercury reaches 6 points above that at which the gold melts for close body, or $4\frac{1}{2}$ points for close gum.

By the use of the thermometer, as above described, it is possible to fuse porcelain to any predetermined degree with almost perfect accuracy, and it is so easily and certainly done that the operator can relegate the fusing to his assistant with the assurance that it will be properly done.

71. Small Arc-Light for Oven.—The most satisfactory assistant for facilitating the observation of the fusing process, however, is the use of a small arc-light as shown in Fig. 14. By means of this adjunct a strong light is thrown in the oven and upon the plate. This light being of a different color from the heat light of the oven, and also one of great intensity, will bring out very clearly any part of the plate that it strikes. Two small carbons are poised on a movable bracket that slips under the name-plate of the oven. One of these carbons is fixed in a spring tube and the other is free to move. The operator keeps the fixed carbon near the middle of the opening. Then, upon

touching it with the movable carbon, an arc is struck. This light enters the small opening in the top, and the operator from in front sees with perfect clearness the part where the arc-light touches. With this appliance all eye-strain is removed, and the operator can watch the fusing process as clearly as if the oven were open. He can not only see the case is fusing, but he can get a fineness of fuse that cannot be obtained in any other way. While with the electric oven, by ordinary methods, the operator has a better view of his case than he ever had in the old-style ovens, the arc-light, as a finishing touch, completes the electric oven for fusing porcelain.

72. Method of Fusing.—When using the electric oven, the dentist should proceed as follows: If the case is a small piece, as a crown or bridge, the lever of the rheostat is put on the first button where it is allowed to stand until the case is thoroughly dried out; when this has been done, the lever can be pushed over to the middle button, and, after standing about 5 minutes at this point, the full current may be put on by pushing the lever to the last button to the right. It might be well to call attention to the position of the rheostat. This should be within easy reach and always placed with the contact buttons at the top. The reason for this is that in case the lever should in time work too freely, it will not fall over on a live button, by accident. While the lever is on the last button, the operator should never leave the case. It should be watched until fused. The operator's eye is becoming familiarized with the appearance of the porcelain, and he can be sure of not overfusing the case, as would very often happen if attending to other matters at the same time. The dentist can, when rushed for time, throw the lever full on at once and thus fuse the case in 10 or 12 minutes, but this should not become the practice because of the temptation to leave the case before the fusing-point is reached. If, however, he acquires the habit of gradually working the lever over to the third or fourth button from the last, and allowing it to remain there until he has the proper amount of time, he will save himself the anxiety, and at the same time be present when the case fuses.

73. Time and Attention Required in Fusing Porcelain. In fusing a full case, at least 30 minutes should be consumed in carrying the case from the cold oven to a full fuse, and a longer time than this is even better, so long as it is held at a comparatively low heat during the first stages. From past experience it can be stated that, for the purpose of obtaining the strongest plate and the most life-like appearance, the heat should be turned on somewhat as a ball rolling down hill gathers momentum, gradually at first and more rapidly toward the last It is for this reason that the operator is advised to use a rheostat, gradually bringing up the heat until the third or fourth button is reached, where it can be allowed to remain until he can give the fusing his undivided attention. The whole oven has become heated up throughout, the case is at the same temperature, and then the lever being thrown on the last button at once, the case quickly fuses. By following this plan the dentist has given the fusing of his case no attention save an occasional pushing forwards of the lever, and when the third or fourth button from the last is reached, he allows it to stand at that until he has time to complete the operation The porcelain is just ready to drop into a fuse, and turning the lever brings up the heat so quickly that he has had just sufficient time for familiarizing his eye with the heat. The time consumed on the first stages may be even an hour's duration, and no harm will follow When the case does fuse, the operator is present at the critical period, and yet but a few minutes of his time has been consumed altogether, and at no stage of the operation was there any danger of overfusing Where the method of turning on one button at a time, as followed by some, is used, the amount of time that personal attention is required is so long that the temptation to attend to other things frequently produces an overfused case.

74. Other Designs of Ovens.—Besides the form shown in Fig 12, the oven is made in two other patterns and sizes. For ordinary full cases and for all crowns and bridges, as well, the oven shown in Fig 12, known as the No. 2, meets all requirements This oven will be found to be the most

satisfactory for the average practitioner or one that constructs crowns and bridges, and an occasional case of continuous gum. For the specialist in porcelain, however, an oven the same in all respects as Fig 12, except that it is $\frac{1}{2}$ inch larger in all dimensions, would be recommended Fig. 16 shows a small oven for crowns, bridges, and inlays. This possesses a marked advantage by reason of the floor being a plane surface. This admits of the most delicately adjusted crown or bridge being placed in position without danger of displacement.

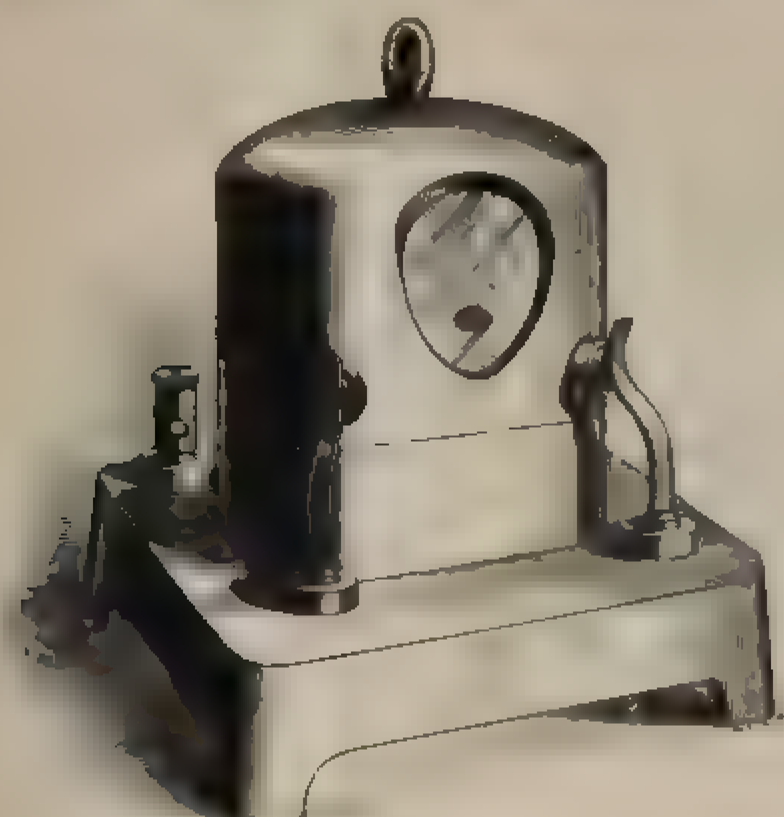

FIG 16.

Custer Electric Oven for Crowns and Bridges

75. Advantages of Custer Electric Oven.—It is advised, however, that the operator use the style shown in Fig. 12, for several reasons: First, the oven itself is the best for annealing that can be had, and we see no necessity for removing the case to an oven that is usually an enclosed muffle. If the case is allowed to remain in the oven until all has cooled together, it is most reasonable to suppose that it will be more evenly annealed than by removing it to a special muffle for that purpose. In changing the piece from

one oven to another, it is subjected to a very sudden change of temperature, which, while it is not sufficient to check the better porcelains, still has no advantage. Moreover, the danger of injury during the removal is avoided. By leaving the case in the oven to cool, the whole process is simplified. A second advantage in this style of oven is found in the arrangement of the sight openings. These are in a more advantageous position for viewing the case, and a much wider range is thereby obtained.

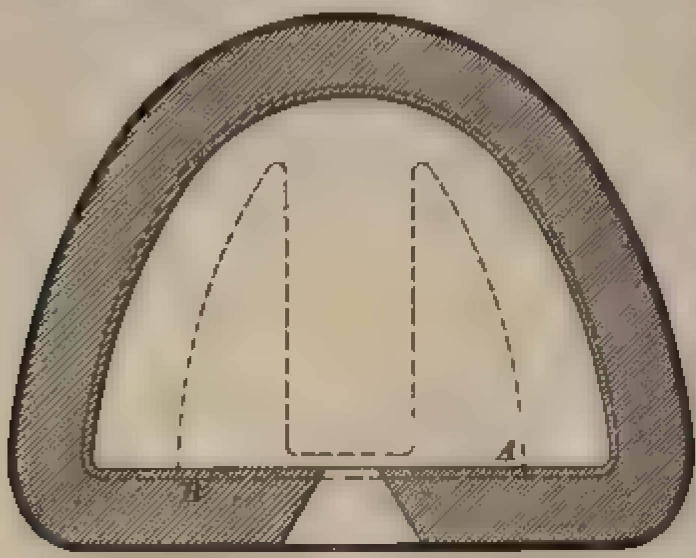

FIG. 17.
Diagrammatic Illustration of System of Wiring.

The system of wiring employed in the large size ovens is diagrammatically shown in Fig. 17. It is very simple and the operator can easily trace it out in case of repair.

CARE OF ELECTRIC OVEN.

76. When the oven was first put upon the market the wires were covered with a thin layer of clay, as a protection against metals and the like, which the dentist would inadvertently use. After it became generally known that the oven was a delicate instrument in some respects, it was sent out with the wires partly exposed. The oven is a sensitive instrument and one easily ruined by abuse. The first care that should be exercised is cleanliness. The platinum wires, while so highly heated, readily take up any foreign substances that may be present. They unite with other metals, thus lowering the melting-point of the platinum, causing a burn-out, while many other substances cause a granular effect on the wire. In order to prevent the possible contamination of the wires, a tray should always be used upon which to rest the work, and the oven should be kept covered when not in use. As an illustration

of what has happened, some dentists use pumice-stone in the investment of their cases. This fuses in the oven, and if a tray is not used it acts as a flux upon the wires, causing a burn-out and an absolutely unreliable condition of all the wires with which the pumice-stone has come into contact. A tray would have prevented this accident.

77. Necessary Precautions.—Nothing should be fused in the oven but porcelain. It should not be used for the melting of metals, for which there is a great temptation. The metals may not touch the wires, but the volatilization of them, which frequently occurs, is certain to injure the wires by uniting with them. The oven should not be overheated; a single overheating will do more damage than many heatings at proper temperature. A molecular change appears to be produced by overheating. The inventor accounts for it in this way: The metal of the wires has almost reached its melting-point, and under the influence of the current the molecules take on a movement from the relation in which they were placed in the drawing out of the metal in the wire form. This movement of the molecules may be brought about by the high heat long continued, but we are of the opinion that it is also largely influenced by the current itself. This force is probably of an electrolytic nature, inasmuch as platinum is not to any extent magnetic. At any rate a crystallization is produced in the wire that is apparent even to the naked eye. It is also proved by the rise in the resistance of the wire. Old ovens consume less current and heat up more slowly than new ones. This is due to the loosening of the molecules and an attempt at polarization, as it were. If, in the use of the oven, the heat of the wire does not approach so near the melting-point that its molecules move in their respective relations, no permanent change of structure will be produced. To be more explicit, it is necessary that these molecules or atoms, during the height of the heat, have a wider path of movement, but it is not necessary that this movement should be so much that they do not return to their original relations, when the oven cools. In practice, it has been found that if the oven is not overheated a

single time, that it will last for hundreds of operations. We have a record of over 800 fusings without a single burn-out. When the oven was first put upon the market it received an immediate backset from misuse. The dentist would at once put the oven to the highest heat possible to see what would happen; or, perhaps, to see if it could stand all the abuses to which he could put it. If it stood this test it was a success, and he would keep the instrument; if not, he would return it to the manufacturer. When the oven did not burn out by this trial it would surely do so in a short time because of the crystallization that took place.

78. To Repair the Oven.—The repair of the oven is a simple process. The clay in time cracks somewhat, but these can all be repaired so as to be as good as new by mixing the repair clay with water, and having first saturated the clay around the break with water, pasting the cracks full of new clay. This bakes hard at the first heating. Sometimes, and especially in large curves, the wires may become loosened from their investment. These can be pressed back with a wooden instrument and held with a thin layer of repair clay. It does not matter how much the wires become freed from their investment, so long as they do not buckle to the extent of touching neighboring wires, no harm will follow. If there has been a burn-out of the wire it will usually be found at the end of one or more of the loops. Expose enough of the wires to get a clear idea as to the plan of wiring as diagrammatically shown in Fig. 17. Grasp the two free ends of wire with a pair of flat-nosed pliers, and, having put a very small piece of No. 4 gold between the two wires, twist them tightly together, cover with a little clay and heat up. If three or four loops in a row are burned out, it is best to strip these loops entirely out and bend in a new piece of the wire furnished for this purpose, first preparing a bed for them by scraping the clay flush with the bottom of the old print of the wire. In making these repairs the greatest care should be exercised that neighboring wires are not injured thereby. The least scratch is sufficient to cause a new burn-out.

THE ELECTRIC CAUTERY AND ROOT-DRIER.

79. Use of Cautery in Dentistry.—While the electric cautery has a somewhat limited use in dentistry, it is of sufficient value, however, to receive attention. This instrument, as illustrated in Fig. 18, consists of a vulcanite handle through which pass two heavy copper wires. These wires extend about 2½ inches beyond the handle. The purpose of having the wires of thick copper is that they may carry the heavy current that is necessary, without heating, and also to give the proper stiffness at the point. One of these wires is broken at a convenient point in the handle and a small switch inserted so as to bring the current conveniently under control. The two wires are bound tightly together, and yet are electrically insulated from each other. At their extreme ends a loop of about No. 26 gage platinum wire connects the two. This loop varies in shape according to the uses for which it is intended.

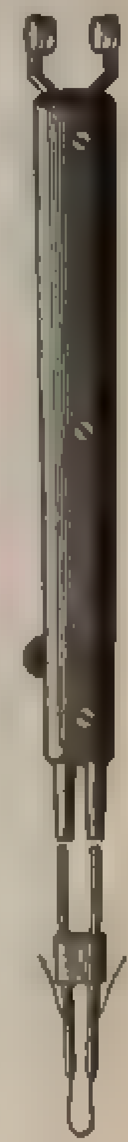

FIG. 18.
Electric Cautery

80. Current Required to Heat Platinum Loop.—The cautery requires a volume of current according to the size of the platinum wire. The length of this wire makes but little difference, but it is the cross-section that is the troublesome feature, because of the large volume of current in amperes required to heat it. A No. 28 gage requires about 5 amperes, and a No. 24 gage about 10 amperes to produce the proper heat. There is required, however, about 4 volts to force this strength of current through the cautery loop, and the conducting-wire leading to and from it. It is an easy matter to get a current of this amperage from a battery, but when taking it from the 110-volt current, it not only necessitates special wiring, but is a very wasteful method. The dental uses, however, do not require a very large cautery, and the dentist can usually get enough current without special wiring. If this is to be taken from battery power, two storage-cells of about 30 ampere-hours capacity can be used for the

purpose. These can be charged either by a gravity battery or by the constant current, by using a 50-candlepower lamp in series. The battery can also be put in series with the dental engine and charged when the engine is in operation. As a rule, there is enough margin in the power of the dental engine to charge a battery of this kind and still have a surplus of energy. The resistance of a storage-battery of that size and capacity is so little as to be practically negligible.

81. Operating the Cautery With the 110-Volt Circuit.—If, however, the dentist chooses to operate his cautery

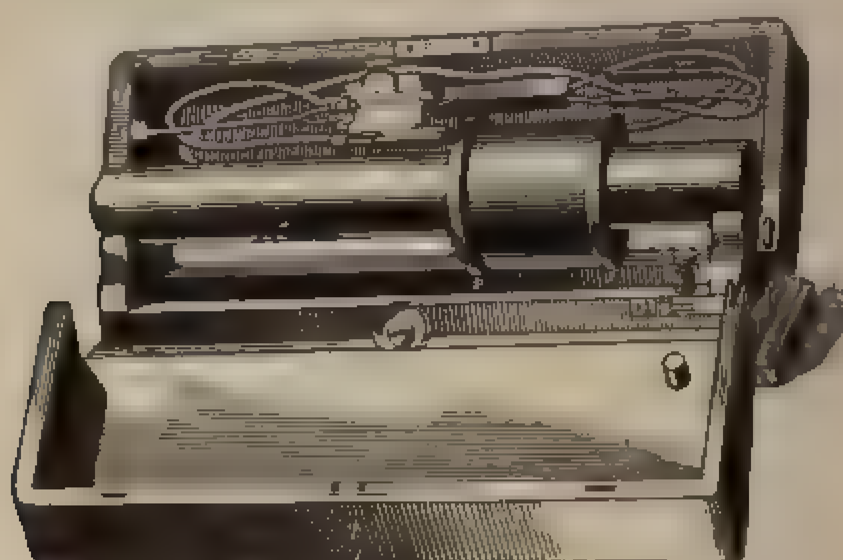

FIG. 19.

Alternating-Current Transformer for Cautery

from the 110-volt current, he can do so by introducing about 10 ohms resistance and taking off enough current for this cautery by a shunt rheostat. By so doing, he can open and close the switch in the handle without having a destructive spark. The breaking of 6 or 8 amperes in a series-break, one that is not in shunt with another circuit, would produce such a large spark as to ruin the handle of the cautery. Making the cautery a shunt circuit, as referred to above, the entire circuit is not broken when the button is raised. It has still another path through which the current can flow, and the spark at the cautery switch is very slight.

82. Alternating Current to Operate Cautery.—The cautery can be much more economically operated on the

alternating current by the use of a small transformer, as shown in Fig. 19. This operates on precisely the same principle as the large transformer. The current is received at 52 or 104 volts, as the case may be, and a secondary current of low voltage but high amperage is produced.

83. Electric Root-Drier. — One form of an electric root-drier can be made by doubling a No. 28 gage platinum wire upon itself and soldering the very tip with pure gold, then dressing this down to a broach-like point. The two free ends are to be fastened to the copper points of the cautery appliances just described. If the two wires do not touch each other from the solder to the copper wires, the heat will be carried to a greater distance into the root. In using the root-drier just described, the heat is obtained by conduction from the platinum point.

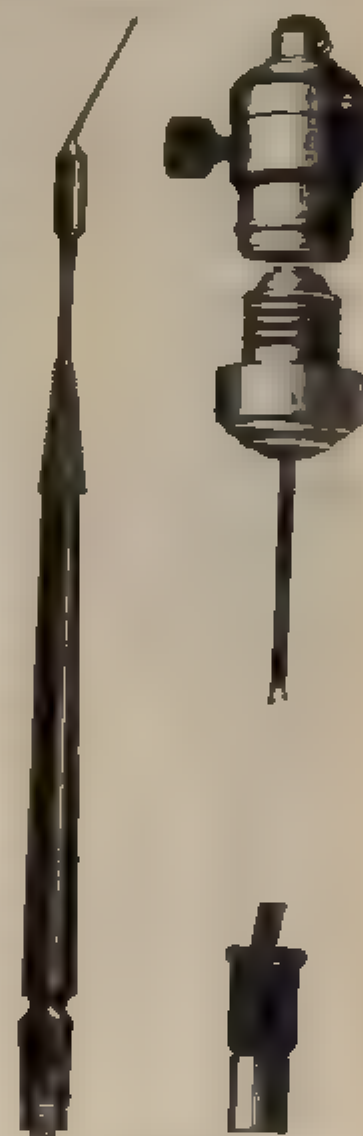

FIG. 20.
Werner Electric Root and Canal-Drier.

The Garhart Dental Manufacturing Company has a very complete root-drier upon the market. The novel feature of this appliance is the method of combining the resistance that is necessary when used on a commercial current, in the flexible cord that conducts the current to the root-drier. In this manner the whole appliance is self-contained, it being only necessary to screw the plug in a nearby socket, when it is ready for use. The root-drier itself is interchangeable with a small lamp shown in another figure.

WARM-AIR SYRINGE.

84. Another form of root-drier and warm-air syringe is one in which the heat is obtained by forcing a jet of air over a heated platinum wire, and the drying done by the heated air. The S. S. White Company has a splendid instrument for this

purpose, which is shown in Fig. 21. This instrument consists of a rubber bulb for producing the air pressure. The point in which the heat is produced is a glass tube containing a platinum coil. This is further protected by means of a perforated metal shield, which allows the operator to see the heating of the wire and also prevents, to a considerable degree, the overheating of the nozzle. The metal point is about the size of a hypodermic needle and can be forced to a considerable distance into the pulp canal.

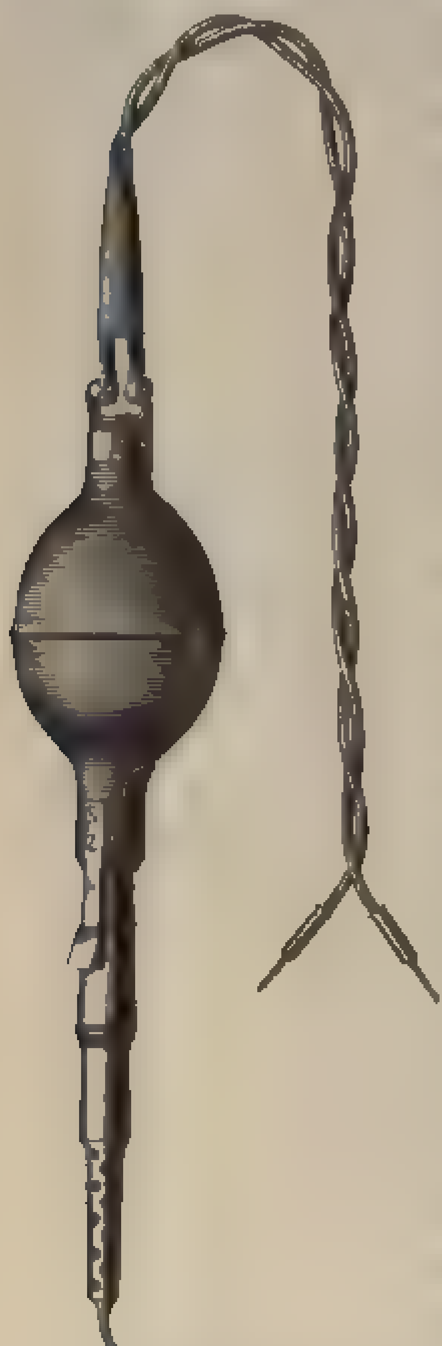

FIG. 21.
S. S. White Electric Warm Air Syringe

A small thumb-switch is placed at a convenient position upon the handle for closing the circuit. This is a great convenience, for the heat of the wire being fixed by the current that operates it, the dentist, by momentary touches upon the button, can obtain a warm blast for sensitive dentin, or, by holding the button down for a length of time, he obtains a hot blast for pulpless teeth. In this manner, this instrument forms a very simple and effective device for either warm or hot air. The temperature of the air can also be varied by modifying the air pressure from the syringe. A light pressure will cause a hot blast, whereas a hard pressure will produce a jet of warm air. The heat of the wire will always remain the same, and any degree of heat can be obtained by the simple manipulation of the pressure upon the bulb.

The heat for the platinum wire can be obtained from the S. S White Company's motor generator outfit, as shown in another figure, or it can be obtained from the Partz motor battery, No 6, or an Edison-Lalande battery.

85. Construction of Warm-Air Syringe.—In the construction of a warm-air syringe, the nearer the heat-producing wires are brought to the tip, the better. Dr J W Wassall devised a hot-air appliance, in which the wires were contained in the tip itself. The wires were wound on a form, and porcelain baked around them so as to insulate them, hold them in position, and, also, afford a passageway for the air. In fact, the walls of the tip were the heating surface, and the air became heated as it escaped from the point. Those that have attempted carrying heated air through a rubber tube of any length will see the wisdom of this device, for it is impossible to carry a jet of warm air any distance through a rubber tube. Unfortunately, this appliance is not upon the market. The Electro-Dental Company, of Philadelphia, however, has one that embodies nearly all the details of Doctor Wassall's warm-air tip. This is shown in Fig. 22.

FIG. 22.
Electro-Dental Warm-Air Appliance.

86. Essentials to Produce a Warm-Air Current. In order to produce a jet of warm air at an absolutely steady heat, three things are necessary. The air pressure must be uniform, the heat of the syringe must be uniform, and the tip must be held the same distance from the tooth. To have a steady air pressure, one must be equipped with compressed air. This may be anywhere from 5 to 15 pounds, but whatever its

pressure, it must always be the same when using the warm air for sensitive dentin. The best method of obtaining this is to use a 60-gallon kitchen tank as a reservoir, and to keep this supplied by an automatic appliance, such as the electric air-compressor to be described, or by means of a water-operated beer-pump. The above appliances can be set to operate at a given pressure.

87. Electrical Heating of Tip.—The heat of the tip must be uniform. Herein lies the value of electrical heat for this purpose. Having once arrived at the proper heat for sensitive dentin and for a pulpless tooth, the rheostat lever can be placed upon the proper button with the assurance that, so far as the electric part is concerned, the heat will be absolutely correct. No agent can take the place of an electrically heated wire for this purpose. The absolute reliability of electricity, the purity of the heat, the perfection of control, and the ease of manipulation are properties not to be had in any other agent or method. The distance from the tooth must also be approximately the same. Nearly every dentist, by habit, places the syringe point about the same distance from a cavity each time, and he can acquire the same habit with the electrically heated tip.

FIG. 23.
Doctor Faught's Electric Gutta Percha Plugger.

ELECTRIC GUTTA-PERCHA PLUGGER.

88. Electric heat has been utilized by Dr L. A. Faught in the packing of gutta-percha. He has designed an instrument, shown in Fig. 23, in which the plugger point is kept at a constant heat by an electric current. The current is conveyed to the instrument in the usual manner, and the heat may be regulated to any desired degree by means of a rheostat The advantages of this instrument

over one heated over a flame are three: The heat can be perfectly controlled by means of the rheostat; there is no danger of overheating the gutta-percha; and the instrument maintains a constant heat throughout the operation.

ELECTRIC STERILIZER.

89. We now come to three simple devices operated electrically, which, although not essential, are great conveniences, and where the dental office is equipped with a current for other appliances, they can be added with very little trouble or expense. These devices are the electric sterilizer, electric match, and warm-water appliances.

90. Appliances for Heating Wire.—It is unnecessary to call attention to the value of heat for sterilization. This can be secured electrically by either a wet or dry method. A vessel of water may be kept at the boiling-point either by the use of ordinary electric heaters immersed in the vessel, or an electric lamp. An electric soldering-iron, which is to be had on the market, with its handle removed, will keep a large vessel of water at the boiling-heat, and an electric lamp of a candlepower varying according to the size of the vessel, will keep the water at the boiling-point. The lamp should be immersed, bulb end down, in order to simplify the construction of the appliance. This arrangement insures dryness of the socket and also a convenient method of turning the current on or off. If a short lamp is used, such as is usually employed for focusing purposes, and with a green globe, the appliance can be made quite ornamental. If a lamp is used in this manner a 4-candlepower lamp will heat a pint of water to the boiling-point and higher candlepower lamps a larger quantity of water.

91. Description of Steam Sterilizer.—The usual form of steam sterilizer for dental instruments, which is upon the market and which is designed to be heated by a gas-jet, can be heated by electricity in the following manner: A piece of $\frac{1}{4}$-inch asbestos cardboard is cut out the size of the bottom of

the vessel. Then 30 feet of No. 26 gage Climax resistance wire is crimped in the cogs of the dental rolls, and this having been annealed by the passage of the electric current through it, is spread back and forth upon the asbestos board and bound thereto by means of little staples of the same kind of wire, care being observed that neighboring rows of wire do not come into contact with one another. A second piece of asbestos cardboard of the same size, but about twice the thickness, is bound to the back of the first piece to prevent the radiation of heat, and also to prevent any accidental short-circuiting of the wire staples. The bottom of the vessel having been covered with a layer of thin mica, like that used for stove windows, it is then placed upon the wires of the asbestos pad and firmly bound thereto. If the two terminal wires are connected to the 110-volt circuit, the water of the vessel will be continuously kept at the boiling-point Thirty feet of No. 26 gage Climax resistance wire will give the proper resistance for 110 volts, and if the same is to be used upon the 52-volt current, it can be done by connecting one wire to the middle of the 30 feet and the other wire to the two ends. By this arrangement the two halves are thrown in parallel, and 52 volts will produce about the same heat that 110 volts produce when the halves are in series.

92. Electric Sterilization by Heated Sand. — The second method of electric sterilization is by dry heat. This can be accomplished by using a bath of clean, white sand in which the instrument points can be buried. The sand is heated to the proper temperature by a coil of German silver or Climax resistance wire, arranged on the inner surface of the containing vessel. After a little experimental work, the exact amount of wire to give the proper heat can be arrived at. The varying conditions of voltage, size of vessel, and individual requirements, are so widely different that a fixed size and length of wire cannot be given. Yet, to begin with, for the 110-volt current, the dentist may take 25 feet of No 30 gage German silver wire or about 30 feet of No. 24 gage Climax resistance wire. If for a very small vessel for engine points

alone, 10 feet of No. 32 gage Climax wire may be used. If for the 52 volt current, about half the above length of wire will be necessary.

93. Sheet-Iron Oven for Sterilizing Purposes. Another method of obtaining dry heat for sterilization is to construct a small oven of sheet iron, and to use within it a ⅛-horsepower Carpenter enamel rheostat for the heating agent. This rheostat will give a fixed heat, and the temperature of the oven can be easily varied to suit the requirements by means of a ventilating window at the top. The rheostat should be fixed upon the bottom with the lever projecting through a slot in the front, which is only large enough to allow the lever to be used upon the first two buttons. In this manner the lever can also be used to cut off the current, and the opening through the sheet iron at this place permits the ingress of air for regulating purposes, the regulating shutter being the one above.

FIG. 24

Custer Warm Water Appliance

WARM WATER.

94. Method of Heating Water.—One of the most pleasing and convenient methods of having a ready supply of warm water for syringe use at the chair is by the use of electricity. A mahogany block 4 in. × 10 in. has at the lower margin a socket for an electric lamp, to receive one of the shortest standard lamps made Just above this is a bowl of green Venetian glass about the size of a large teacup This bowl is deeply concaved under its base. This concavity rests upon the lamp, as shown in Fig 24. The lamp, if a 4-candlepower

one, will raise the water to about 115° F. in the bowl, while that in the bulb will always be found to be within a very few degrees of blood heat. A higher candlepower lamp will keep the water too warm for practical use. If a bracket is placed above the bowl for the mouth-mirrors, they will be kept warm, and the fogging, which is always present upon cold mirrors, will be overcome.

FIG. 25.
Electro-Dental Water-Heater

The amount of current used by this appliance is so little that the dentist can afford to burn the lamp all day. If rain or filtered water be used in the bowl there will be very little precipitation from the evaporation, and the green-glass lamp will give an ornamental effect that is pleasing to the patient.

The Electro-Dental Company has a warm- and hot-water appliance on the market, which is shown in Fig. 25. This appliance is wired to give both warm and hot water. The base is electrically heated, and the glass, by conduction, heats the water within. This is a very simple and neat appliance for this purpose.

THE ELECTRIC MATCH.

95. The electric match is about the only one that can be relied on to ignite every time. This instrument was first exhibited by Dr. L. E. Custer as a part of his electrical cabinet, in 1893. It consists of a vulcanite handle with two projecting springs, which are tipped with platinum, or preferably with carbon. The object in using either of these for the tips is that the spark in time will affect other metals, which might be used for the purpose, and preference is given to carbon because of its certainty of electrical contact, large spark, and cheapness. If the ends of the wires have small cups $\frac{1}{8}$ inch in diameter, hard-soldered thereon, small pieces of $\frac{1}{8}$-inch carbon may be cemented in them with a cement made from the carbon dust

and sugar syrup. The metal cups should be fixed at an angle of about 25°, as shown in Fig. 26.

96. Method of Operating Electric Match.—This fixture is hung at any convenient place near the chair by the cord that conducts the current thereto. The resistance for the match to give the proper spark should be about the same as that for a $\frac{1}{8}$-horsepower motor, or for the electric gold-annealer, and either one of these can be used for that purpose. By connecting the two wires from the match around the switch that operates either the engine or the annealer, it takes the place of the switch, and the spark that would appear at the switch now appears at the match. The match is operated simply by pressing the springs together until the points touch, when a small arc will be struck. This can be maintained indefinitely by holding the points about $\frac{1}{8}$ inch apart. When through, the arc will be extinguished by releasing the springs.

FIG. 28. *Custer Electric Match.*

If it is desired to have a separate resistance for the match, a 50-candlepower lamp, an old, small rheostat, or a 200-watt resistance lamp will answer the purpose. Any number of these matches can be operated from the same resistance by connecting thereto, the necessary requirements being an individual cord running to the place where each match is hung. These, to be convenient, are hung at each gas-bracket or gas-valve.

THE ELECTRICAL MELTING OF PLATINUM.

97. Source of Heat.—The form of heat used in all the foregoing, except the electric match, is that produced by the resistance of the metal conductor. The range of heat in these cases was limited by the fusing-point of the metal. We now come to a form of heat in which the electric current, without any conductor, produces the heat. If, with a given pressure, we introduce into the circuit a short piece of metal of moderately high resistance, such as an iron wire, the wire will become

heated to a certain degree. If, now, we substitute for the iron wire, one of German silver, whose electrical resistance is about twice that of iron, the German silver will be raised to about twice the heat of the iron. And so we may go on, increasing the resistance and with that the heat, until we have the tremendous heat of an electric arc. In the electric arc we have no metal of any kind to act as a path for the current, however high its resistance may be, but we have, instead, the atmosphere, whose resistance is infinite. The atmosphere is a non-conductor ordinarily, and the current in passing through it exhibits itself in the form of heat alone. It is for this reason that the heat of the electric arc is the highest that man can produce. It is so high that its measurement is not an absolute certainty, but it is estimated at about 6000° F.

98. Production of Electric Arc.—The electric arc on a commercial circuit is produced by touching two live terminals together, and then withdrawing them. It requires about 45 volts to maintain it when once established by prior contact. But, to establish it without previous contact requires a pressure of about 50,000 volts for every inch. The arc having once been established, however, the current continues to flow across the break until the distance becomes too great, when it ceases.

99. Practical Use of Arc Heat.—In order to make a practical use of this intense heat in dentistry, and especially for the fusing of platinum, the scrap of which heretofore was practically worthless except for the small price that was paid for it as scrap, a method was devised by Dr. L. E. Custer of using the electric arc for this purpose. This method can best be used upon the 110-volt constant current, and will be described for such current.

The method of 1893 was found to produce a very hard platinum. This was followed up in detail by Doctor Custer, and, in 1898, he devised a method of producing soft platinum, as soft, indeed, as new platinum. The difference between the two was not due to a different form of heat, but to the presence or absence of carbon while fusing the platinum.

100. Method of Producing Hard Platinum.—The first method, and that for producing hard platinum, is as follows: From 8 to 12 ohms resistance is introduced in the circuit to prevent blowing out the fuses. This resistance can be had by using a large-size electric oven, without a rheostat, or a special rheostat can be made by using a sufficient length of No. 14 German silver wire. For making the connections for fusing the platinum, one wire is attached to one side of the oven and the other wire is attached to the other main. These wires should be about No. 16 gage lamp-cord. The two terminals are now tested for polarity by dipping in acidulated water. Bubbles of gas will form on the negative. Attach

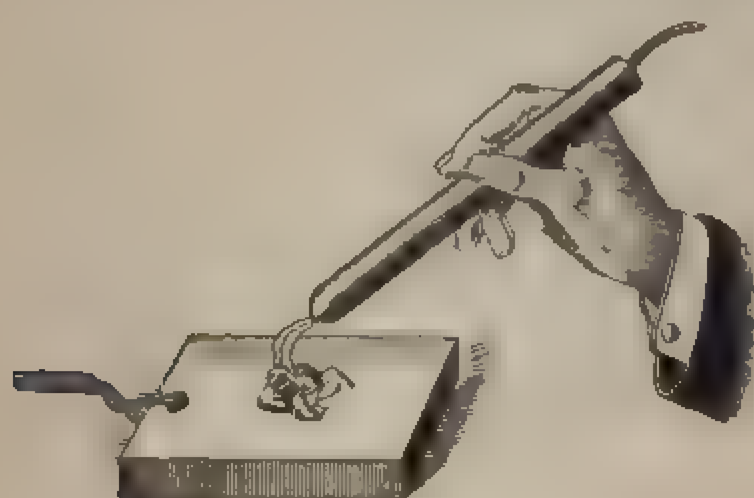

FIG. 27

Carbon Process for Fusing Platinum

this terminal to a long electric-light carbon and the other terminal to a piece of carbon battery plate, as shown in Fig. 27.

By connecting in this manner, the platinum scrap becomes the positive pole, which is the hotter of the two. There will be more rapid fusings of the platinum and less noise than if the connections were reversed.

When the connections have been made, the platinum scrap is heaped up in the center of the carbon block. The pencil is brought to touch the platinum and then withdrawn a short distance, readily determined by trial. An arc is thus established and the platinum, which forms the positive terminal, is quickly melted. With 12 ohms resistance, from 6 to 8 pennyweight can be fused at once, and with 8 ohms, nearly an ounce

can be fused in a body. By this is meant that the whole mass will be in a melted condition at one time. There is no limit, however, to the amount that can be formed into a single piece. It is not necessary to have the whole mass in a melted state at one time, the edge of it, only, may be melted and the new metal added while in that condition. In this manner ten ounces have been melted into one rod at one time. This rod was so uniform that it was afterwards drawn out into a fine wire.

101. Protection of the Eyes.—The light of the arc is so intense that the eyes should be protected by the use of the darkest glasses that can be obtained.

102. Advantage of Low Voltage of Current Supply.—While the dentist is dealing with one of the most wonderful electrical phenomena in fusing platinum, if he is using the 110-volt constant current there is no danger of more than a slight shock should he accidentally complete the circuit through himself. He can therefore handle the carbon pencil with his bare hands, with impunity.

103. Condition of Platinum When Fused by Carbon Process.—The platinum, fused by the foregoing, which we may call the *carbon process*, becomes somewhat harder than new platinum. This is due to its taking up carbon while in the melted state. It appears that platinum is affected in a manner similar to iron by the addition of a small percentage of carbon. A nugget of platinum that has not been instantly fused becomes hard like platinum-iridium, and if the process is kept up for some time it becomes brittle, and when struck with a hammer may fly to pieces.

The platinum fused by the carbon process is of special value where stiffness and strength are needed. By actual test, with the proper proportion of carbon, this platinum possesses almost twice the stiffness of new platinum, and for this reason it makes the best of material for making the pin of a crown, the framework of a bridge, for the back lining in continuous gum cases, and for strengthening gold fillings.

104. Soft Platinum Produced by Lime Process. The second method of fusing platinum, whereby it retains its virgin ductility, was also devised by Dr. L. E. Custer, in 1897, and may be called the *lime process.* It is precisely the same as the carbon process except that a block of unslaked lime is used instead of the carbon plate, and a platinum-pointed pencil takes the place of the arc-light pencil. In so doing there is no carbon present, and the platinum being unaffected by the lime, appears as soft as new platinum.

The block of lime should be made level on top if the platinum is to be used for a plate, and it should be grooved slightly if to be made into a wire. The lime is not a conductor of electricity, as is carbon; it only acts as a receptacle to hold the platinum, whereas the carbon plate is both a conductor and a receptacle. Electrical connection is therefore made by tying a piece of heavy platinum wire, or preferably several smaller wires, to the end of the positive wire. This makes a platinum terminal for the wire that is laid on the block of lime, and the platinum scrap is heaped upon that, as shown in Fig. 28. This completes the metallic connection to the platinum scrap. When the scrap has been fused, the terminal wire is severed from the nugget.

FIG. 28.
Lime Process for Fusing Platinum.

105. Construction of Platinum-Pointed Pencil. The platinum-pointed pencil should be made by using a piece of brass rod $\frac{3}{8}$ inch in diameter and about 8 inches long, with a wooden handle thereon. The other end of the rod contains a slot in which a nugget of platinum of at least $\frac{1}{2}$ ounce in weight is bound. This nugget, while not very large, will not fuse because of its negative polarity and of its attachment in the metal rod, which conducts the heat away.

106. Method of Establishing an Arc.—When fusing by this method there will be a tendency of the scrap and nugget to unite while either melted or by cohesion, but a little experience will teach one how this can be avoided. A fine carbon pencil, or even the lead from a lead pencil, can be used between the platinum point and the scrap to establish the arc, and then withdrawn without measurably affecting the ductility of the platinum.

107. Advantages of Soft Platinum.—Platinum, which has been fused by the lime process, comes out as soft and ductile as new platinum, and will be found to possess all its properties. It is even possible to burn out impurities by this method, so that prolonged melting is also a refining process. This platinum can be used for swaging, for backings, and for inlay matrices, and in fact for all those purposes where soft platinum is indicated.

POWER.

THE ELECTRIC MOTOR.

108. Discovery of the Motor.—The electric motor is said to have been discovered at the installation of the Vienna Exposition in 1872, when, by accident, the mains from a dynamo on exhibition happened to become connected to another dynamo near by. It was noticed that when the first dynamo was put into operation, the second also began running. Nevertheless, it is now a well-known fact that a dynamo will act as a motor, and vice versa, and that but little change is necessary to make the same machine operate efficiently either as a dynamo or motor.

109. Rating of Motors.—The dynamo is rated in kilowatts, while the motor is rated in horsepower, for the reason that the dynamo generates electricity whose output is estimated, electrically, by the term *watt*, while the motor converts electricity into power, and for that reason its output is reckoned in *horsepower*.

110. Construction of Motor.—The motor, to all external appearances, resembles the dynamo, and, if a constant-current machine, consists of a *field*, *armature*, *commutator*, and *brushes*. If it is to be operated by an alternating current, then like the alternator, the brushes are wanting. The winding of the motor is also similar to that of the dynamo. It may be *series*-wound, *shunt*-wound, or *compound*-wound.

The field of the first small motors was of the horseshoe type. There was no attempt at enclosing the armature, as was done later for the purpose of producing a stronger field, and at the same time making the appliance dust-proof. This part of the motor was formerly made of the softest cast iron, but, owing to the great changes in the designs, many manufacturers are now making the field of laminated iron. This has the advantage over cast iron of being more highly magnetic, and of not becoming heated.

111. Style of Motor Used by Dentist.—All the smaller motors are of the two-pole variety; in fact, only the very largest motors have four or six poles. In this respect, dynamos and motors differ. All the motors with which the dentist has to do have but two poles. The motor may be entirely encased, as with those used for driving lathes, and they may have the appearance of having four poles, but upon examination they will be found to have but two.

112. The Armature.—The armature is precisely the same as that used in the dynamo. It may be a *ring* or Gramme type, or it may be a *drum* or Siemens. While, in the course of the improvement that motors have seen since they were first introduced, the field has been considerably modified, the armature has not been changed in the least, and it remains to-day the same as at first; it is either a plain Gramme or a Siemens armature. In the larger motors the Gramme armature is used, and in the smaller, the Siemens. The same principles of construction are carried out that are used in the manufacture of armatures for dynamos. The most popular form at present is the drum type, because of its simplicity of construction, compact

bulk, and the consequent small proportions of the whole appliance.

The commutator and brushes are used on direct-current motors, and are also the same as those of a continuous-current dynamo.

113. Value of Motor in Dental Work.—One of the first applications of commercial electricity in dental practice was the use of the electric motor. This had been scarcely perfected before dentists recognized its value in their work. It was soon established in both the operating-room and the laboratory, and to-day there is scarcely a well-regulated office in which electricity is available that does not make use of one or more electric motors.

No single appliance has done so much to elevate the tone of the dental office as the introduction of the electric motor and engine. It has transformed a performance that reminds one of the scissors-grinder, and one that was chiefly a physical operation, into one that partakes more of a digital and mental operation. The dentist has no longer to treadle a wheel that an engine burr may revolve, but, by the mere touching of a button, the burr is set in motion and the attention of the operator, instead of being divided between treadling a wheel and the management of the instrument in the tooth, may now be concentrated upon the latter. The body of the dentist may then be perfectly quiet, and the burr controlled with a steadiness and sensitiveness of touch that is not dulled by body vibration. In the course of time the management of the electric engine and switchboard becomes automatic, and the dentist controls these without going through the mental routine.

ELECTRIC ENGINES.

114. The first electric engines made their appearance in 1885. The Griscom was attached to one end of the White flexible arms and was suspended over the operating-table. The Detroit motor was a separate fixture. From these, a few years later, was evolved the Kells system of motor and engine. While new improvements were made at a very rapid rate, they

were principally in the minor details. The general features of the very first engines and systems are still adhered to.

115. Classification of Dental Engines.—The dental engines of to-day may be classified into three groups. Those in which the motor is attached directly to the arm piece; those in which the motor is attached to the base of the engine; and those in which the motor is placed at some distance from the engine arm and power is transmitted thereto by a long belt The first class is represented by the Griscom, the second class by the Detroit, and the third class by the Kells.

116. Columbia Dental Engine.—The first class is found on the market to-day under the name of the Columbia engine, which is illustrated in Fig. 29. The motor part of this engine is about $\frac{1}{12}$ horsepower The field is spherical in shape, and is encased in a metal cover that makes it noiseless and dust-proof. One end of the armature shaft is attached to a flexible arm. In making this attachment, an insulating material is inserted between the motor and flexible arm, the purpose of which is to protect the patient in case of accidental grounding of the wiring of either the field or armature. If grounding were to occur and the patient were to touch the ironwork of the chair to which a fountain cuspidor is attached, he would receive a severe shock. While it is not intended that the wire of the motor should touch any metal part, this sometimes accidentally occurs in the best of motors, and the use of the insulating coupling prevents what would not be a fatal, but a very unpleasant occurre is balanced in

FIG. 29.
The Columbia Dental Engine

a swivel-like yoke, with which it is suspended. In using it the dentist has only to sustain the weight of its flexible arm. The electric conductors that carry the current to and from the motor serve to suspend the motor at a convenient height from the chair. These wires are bound into a single cord, which passes up to the ceiling, thence over a pulley to the wall, and then down over a second pulley, where a weight equal to that of the motor is attached. This arrangement permits of ample and free movement of the motor in all directions.

117. Special Construction of Switch.—The foot-switch is unique in its construction. It is wired so as to operate the motor in either direction by pushing the lever to one

FIG. 30

The "Sphere" Electric Cable Engine

side or the other. It also gives several speeds to the motor. A feature of special importance is the absence of a destructive spark when opening the circuit. Many rheostats become more or less of a nuisance by the effect of the spark upon the first button. The destructive action causes a condition of the contact and lever that makes its manipulation uneven and uncertain. The makers of this switch have overcome this trouble

by the introduction of a very high resistance at the last step, which cuts down the spark to such an extent as to make it negligible.

118. The "Sphere" Electric Cable Engine.—As another illustration of the first type of electric engines, we may

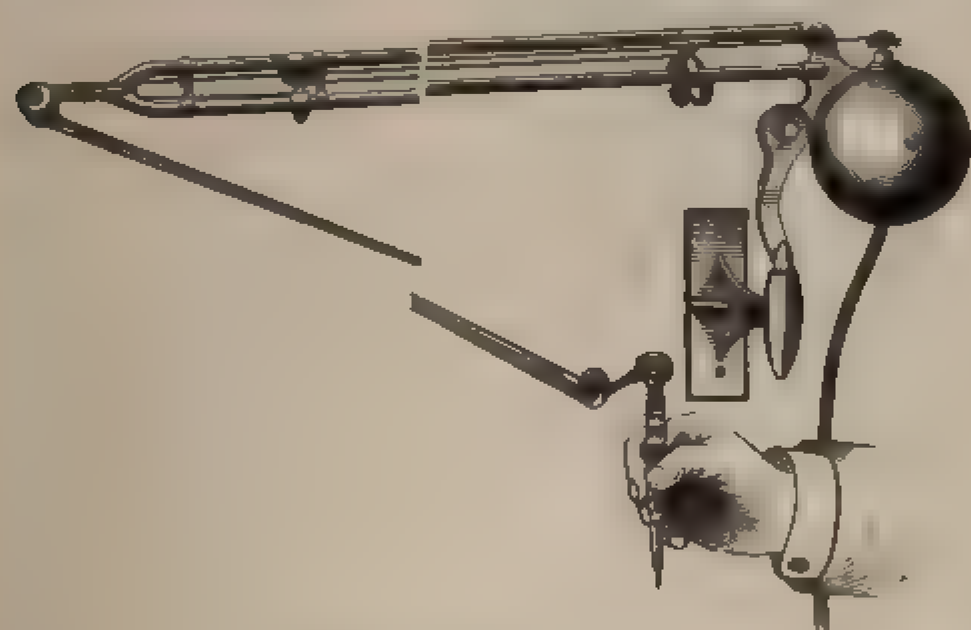

FIG. 31

Register All-Cord Electric Engine

take the engines made by the Electro-Dental Manufacturing Company. One of these, as shown in Fig. 30, has its motor pivoted in a wall bracket, and power is communicated to the hand piece through a rod and flexible cable of about equal length.

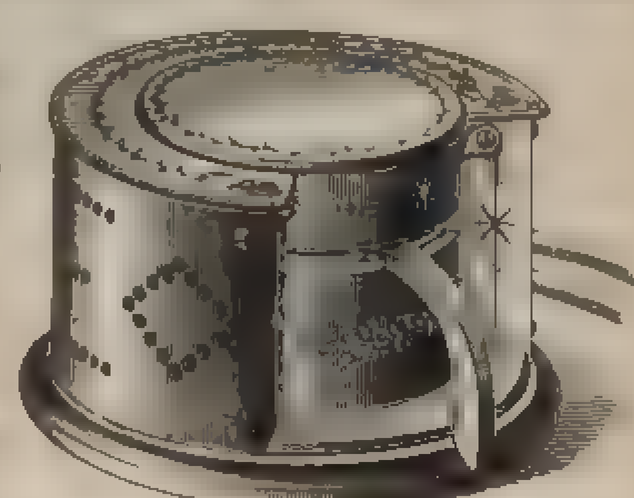

FIG. 32.

Foot-Switch

119. Register All-Cord Electric Engine. The Electro-Dental Manufacturing Company also has an all-cord engine mounted in a similar manner, except that the motor shaft is in a perpendicular position, as shown in Fig. 31. Both styles of engines are to be controlled in the same manner by the movable foot-switch, as illustrated in Fig. 32.

120. Foot-Switch.—Pushing the lever of the foot-switch, Fig. 32, to the right increases the speed of the motor in its forward direction, and pushing the lever to the left regulates the speed in the opposite direction. It gives four speeds in the

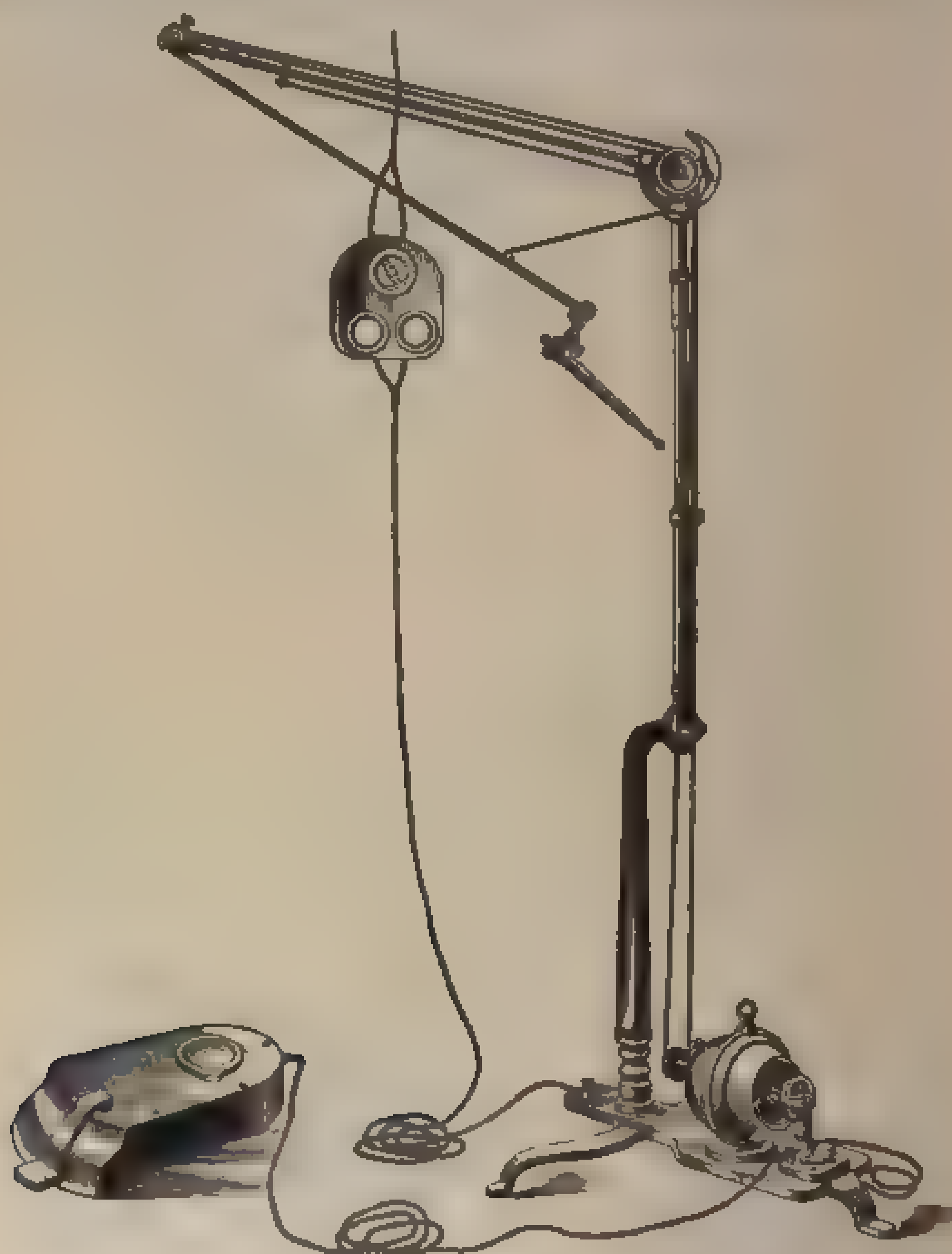

FIG. 33.

S. S. White Motor and Engine.

forward, and two in the reverse, direction. The lever may be locked at any position so that it is not necessary to keep the foot against the lever at all times. A slight touch will release the lever, when it will return to the center and stop the motor.

121. S. S. White Motor and Engine.—As an illustration of a modern engine equipment of the second type we take the S. S. White, as shown in Fig. 33. In this the motor forms part of the engine base. The upper part may be a cord engine,

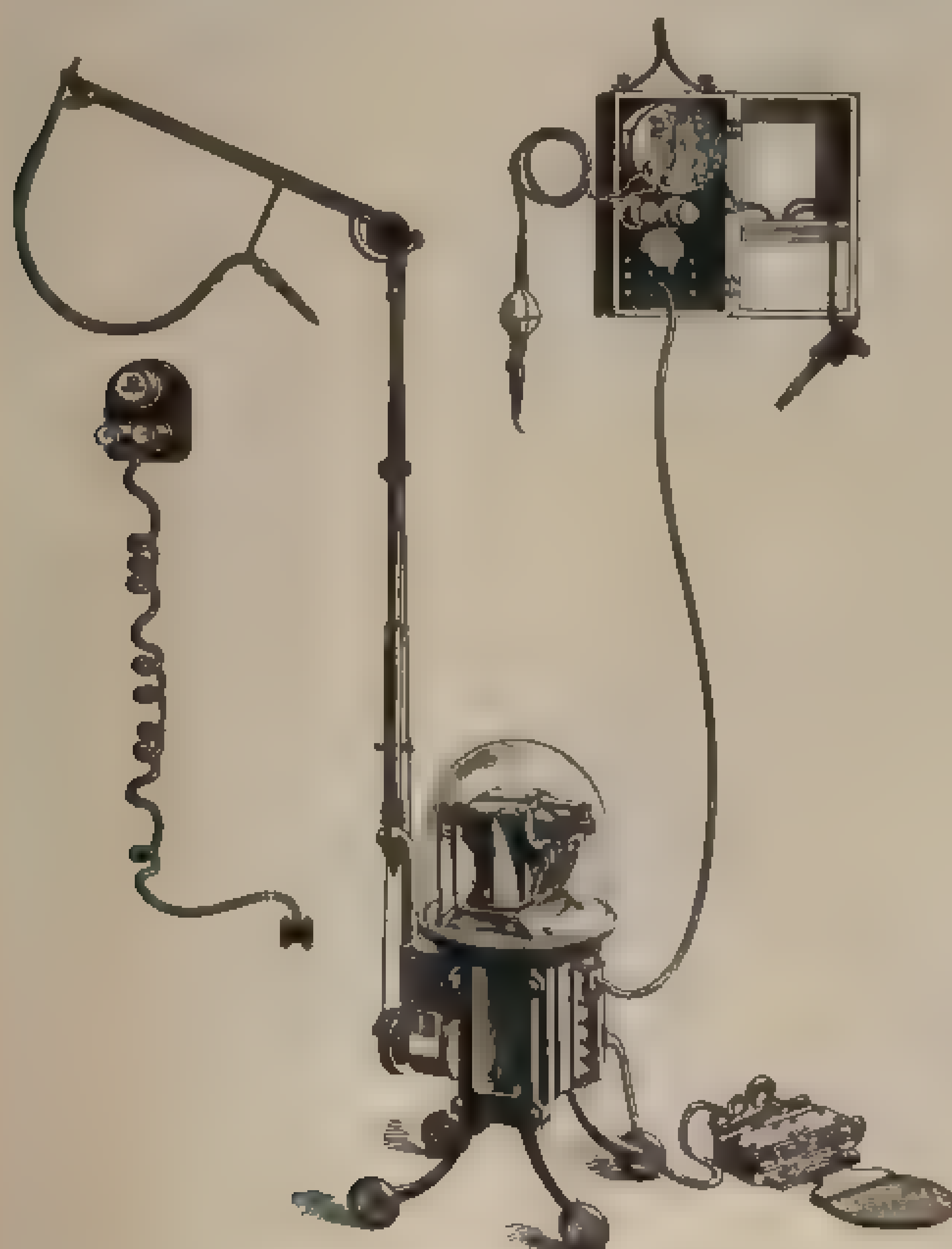

FIG. 34.

S. S. White Motor and Engine Combined

as shown, or it may have the flexible arm. The engine can be moved about the chair in the same manner as a pedal engine, and except that it is somewhat heavier by reason of the motor, one who is accustomed to the old style finds little difficulty in adopting the new.

122. S. S. White Motor and Engine Combined.—The S. S. White Company has another engine on the market in which the motor is a part of the base of the engine. This, as shown in Fig. 34, is somewhat heavier, but being provided with castors, can be easily moved about. The motor is encased in a glass cover that renders it noiseless, and also protects it from dust. It is made to operate in either direction and at various rates of speed. It also has a unique feature in the brake. A disk fixed near one end of the pulley shaft below becomes magnetic by the touching of a button on the foot-switchboard. The disk thus magnetized attracts another disk, which is upon the same shaft, and which also serves as the pulley wheel. The adhesion of these two instantly stops the belt.

FIG. 35.
Berry Engine

The motor is of the motor-dynamo class, by which is meant that while it is operated by an electric current on one end of the armature, it will also give off another current from the other end. The current yielded by this motor-dynamo is especially intended for heating purposes, such as the root-drier, the cautery, and electric mallet, which are supplied with the outfit as shown.

123. Berry Electric Engine. The Berry electric engine, illustrated in Fig. 35, is somewhat smaller than the ones just described. However, it has the foot-switch embodied in the base in such a manner as to resemble the treadle engine. This engine is one that is well adapted for the use of those that do not wish to change from the conventional form of dental engines.

124. Rheostat Operated by Treadle.—In Fig. 36 is an enlarged view of the base. It will be seen that the motor takes the place of the wheel, and the treadle operates the rheostat lever for regulating the speed of the motor. The

dentist that has become accustomed to the treadle engine will very easily learn the management of such an engine as this.

125. To Convert Treadle Engine Into an Electric Engine.—It requires but little ingenuity on the part of the dentist to convert his foot-engine into one of the former style. An ordinary fan motor of $\frac{1}{12}$ horsepower, such as can be had upon the market at a cost of from 12 to 15 dollars, will meet all the requirements. This should be firmly fixed on the base in such a manner that its pulley comes as nearly as possible in line with the upper pulley. If the wheel of the old engine is removed, no difficulty will be experienced in doing this. The proper speed will be attained for the shaft if the pulley wheel of the motor is about the same size as that on the head of the engine.

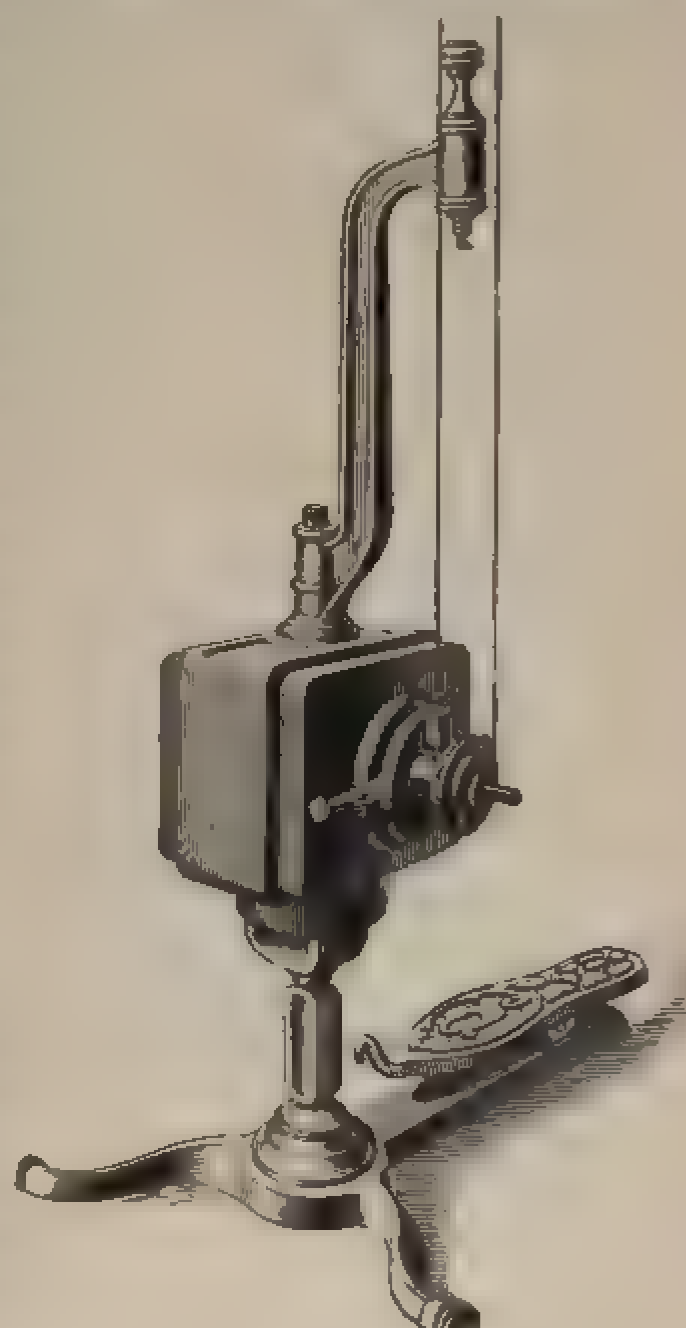

FIG. 36.

Motor and Switch of Berry Engine

126. Motor Situated Some Distance From Engine.—In taking up the third type of electric engines, or those in which the motor is situated some distance from the engine, and power transmitted thereto by means of a belt, we find a large variety of styles. We may first take one

of the S. S. White engines. This company has supplied a line of engines of such a variety as to meet all the requirements of current, and about all the whims of operators. It furnishes

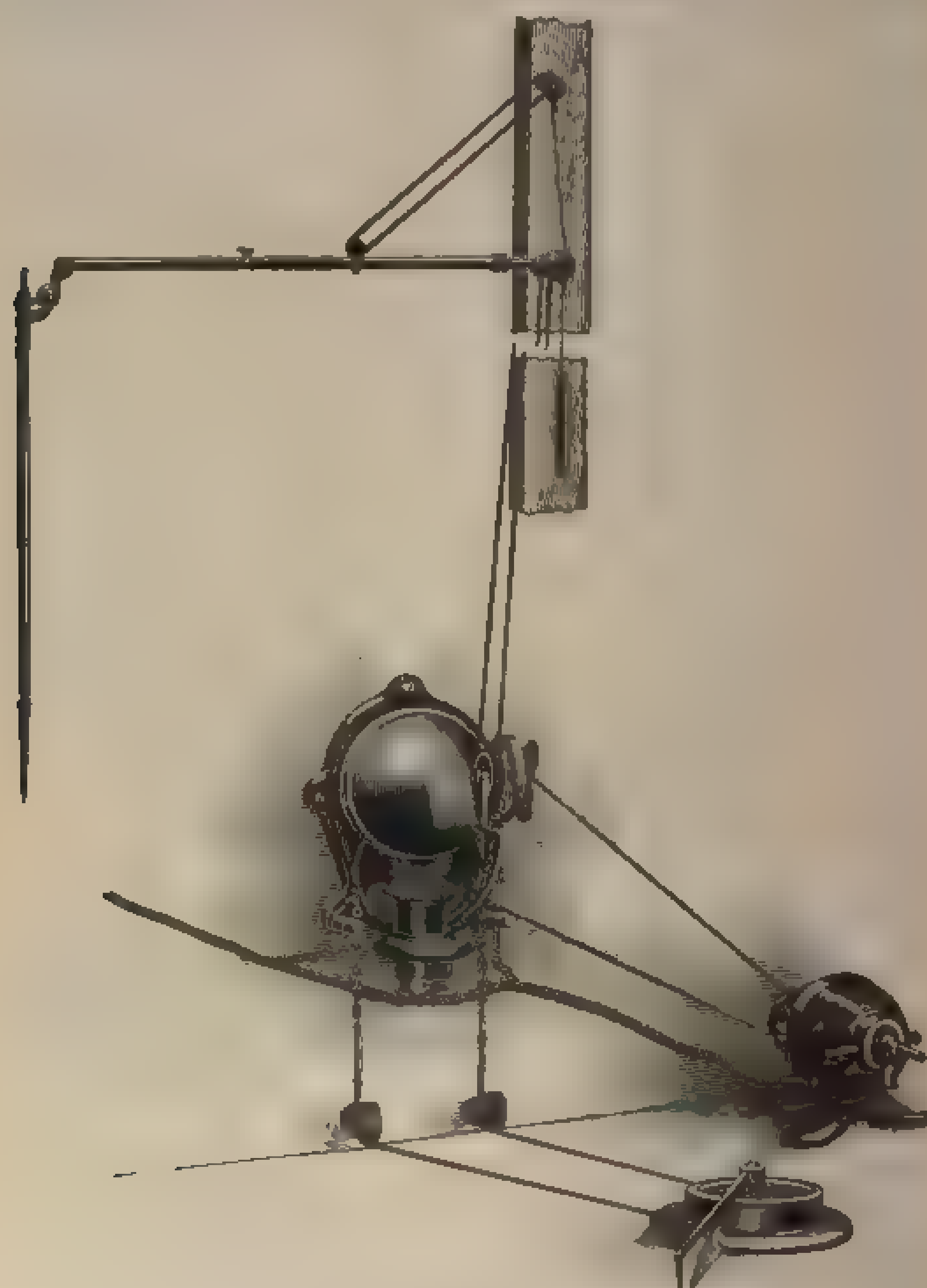

FIG. 37
S. S. White Engine of the Third Type

dental engines of all three types, some of which have already been described, but the favorite ones are of the third type. Probably the most convenient style is that in which the flexible

sleeve is pivoted upon the end of a bracket fastened to the window frame, as shown in Fig. 37.

127. To Regulate Tension of Belt.—The bracket is provided with an extension arm for preserving the proper tension upon the belt. The spiral spring of the first section gives a supple flexibility to the hand piece, and this is further aided by the lateral movement at its pivotal attachment to the bracket. Moreover, the pivoting of the bracket at the wall permits of its being pushed aside when not in use, as well as giving additional freedom of movement to the arm. The motor is placed upon the floor and the usual form of switchboard is provided, which can be placed at any convenient point about the chair.

128. A Cord Engine of the Third Type.—The same company also supplies a cord engine somewhat upon this plan. Instead, however, of the movement of the arms being in a lateral direction, it is at right angles. The two arms of this engine are of about equal length. A balancing weight sustains the weight of the two, so that the operator has only to manage the hand piece. While all cord engines have not that freedom and flexibility of movement of the hand piece, this form of engine is quite popular because of the direct impulse given the burr by the motor. The "backlash," as it is called, is avoided by this arrangement. The motor is usually placed upon the floor, and the cord runs direct to the hand piece without the intervention of a spiral spring.

129. Regulation of Speed of Engine.—The engine shown in Fig. 37 is one that can be operated by an alternating-current, as well as a direct-current, motor. The friction device shown .n the center of the figure is intended to be operated by a motor running at a constant speed, and the variable speed for the engine is obtained by shifting the position of the small friction wheel upon the face of the larger disk. This device differs from most appliances of its kind, the disk being the shape of half a sphere and the pulley wheel being carried upon an arm that is pivoted at a point that is in line with the center of the sphere.

130. Operation of Switch.—The foot-switch of all regulators of this style is fixed at a convenient point under the chair, and motion is communicated to the movable arm by means of two wire cables. Shifting the lever to the right moves the arm in that direction, which gives the engine a forward motion, and shifting the lever to the left reverses the direction. The speed of the burr is regulated by the distance that the friction pulley is from the center of the disk.

131. The Taggart Electric Engine.—An engine devised by Dr. W. H. Taggart in 1887, in point of simplicity and effectiveness, and one that may be said to be a compromise

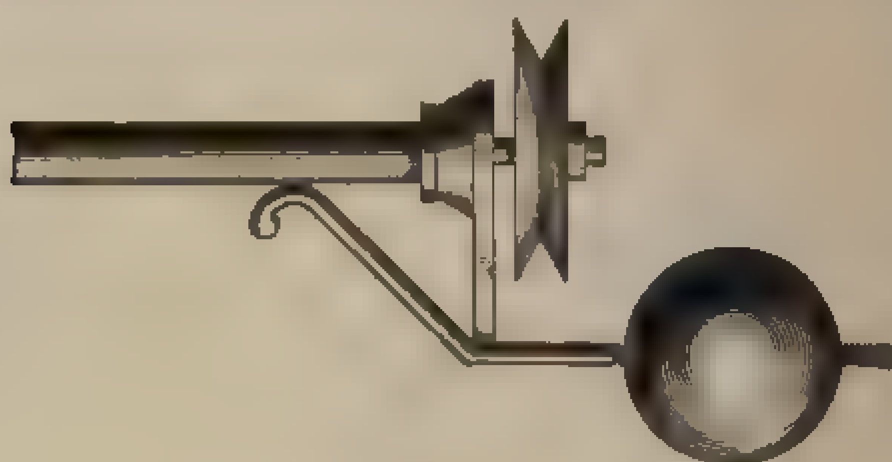

FIG. 38.
Balancing Head of Taggart Engine

between the flexible arm and the cord engine, deserves mention.

If the arm of the Shaw engine be removed from the upright, and an L-shaped piece be soldered below the pulley, as illustrated in Fig. 38, and a ball of metal about 2 inches in diameter be drilled and tapped so as to screw on the arm, the engine is complete. The motor should be of $\frac{1}{8}$ or $\frac{1}{12}$ horsepower This can be stationed anywhere about the office. If the dentist wishes to be economical, this motor can be used in the laboratory for running the lathe, also, and the belt run from this to the chair. Two pulleys of hard rubber, such as are used on the S. S. White cord engine, should be mounted on a rosette of wood, about 5 inches apart, and this rosette fastened to the ceiling at a point directly over the right arm piece of the chair. A belt of fishing line or a good grade of corset twine is brought

from the motor through the two pulleys and down to the pulley of our dental arm. The rosette is turned at such an angle that when the engine hangs at rest it will be out of the way of the operator.

132. Desirable Features of the Taggart Electric Engine.—This engine has several desirable features. It has all the flexibility of others by reason of the two short flexible springs, one at the hand piece and one in the arm, and the universal joint at the pulley. It has but little backlash because of the short length of the spiral spring in the shaft line. By screwing the weight backwards or forwards, the hand piece can be so exactly balanced that the operator has no weight to handle. A hook near by holds the arm out of the way when it is not in use.

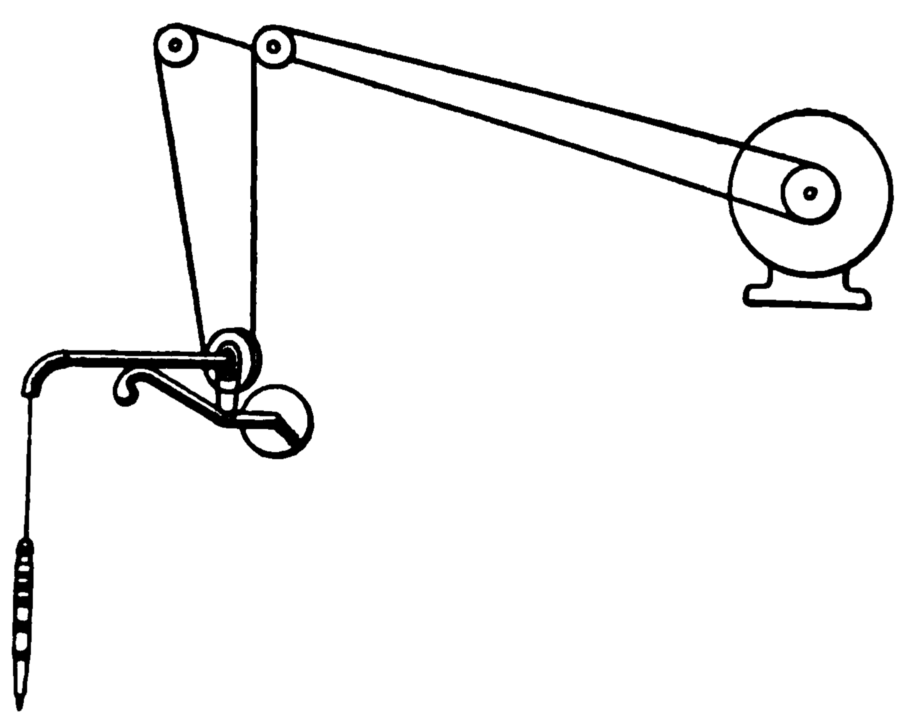

FIG. 39.
The Taggart Electric Engine.

133. Other Uses of Motor.—If the dentist wishes to perfect this in detail, so as to use the one motor for both purposes without changing the belt, a magnetic pulley on either end of the shaft, one for the lathe and one for the engine, can be automatically clutched by the mere operation of the switch for whichever instrument he is using. The electromagnets for this purpose should be wound with the same size of wire as the field of the motor, and placed in series with it. They should be about 1 inch in diameter and 2 inches in length, and should be poised as close as possible to the back of a soft-iron disk on the end of the shaft. This disk should be electrically insulated from the shaft by a bushing of fiber and yet should be firmly fixed thereto. It should, moreover, be turned perfectly true on both surfaces after being mounted. Just inside of this disk

toward the motor is a loose pulley of soft iron with a fiber bushing that insulates it from the shaft, as is shown in section in Fig. 40, which represents one of the armature shafts.

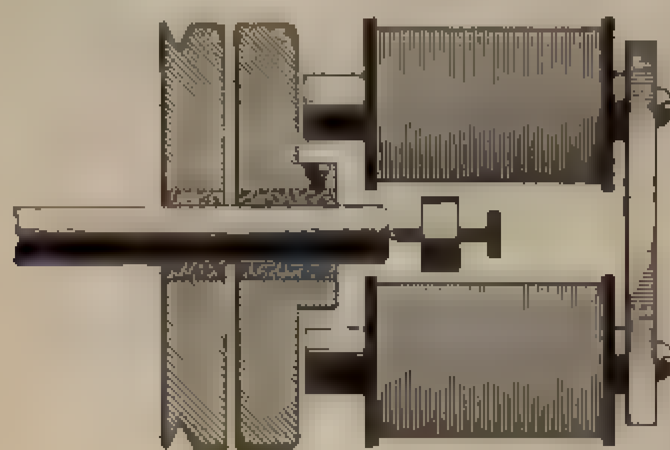

FIG. 40.
Electric Clutch

When the magnet is energized it induces magnetism in the fixed disk at the end of the shaft. This, in turn, attracts the loose pulley to it so firmly that it becomes a fixed pulley for the time being, or as long as the current is supplied to the motor through the electromagnet at this end. A needle-pointed setscrew makes accurate adjustment of the shaft, and also receives the end thrust produced by the magnetic pull.

The other end of the shaft is to be precisely the same, and

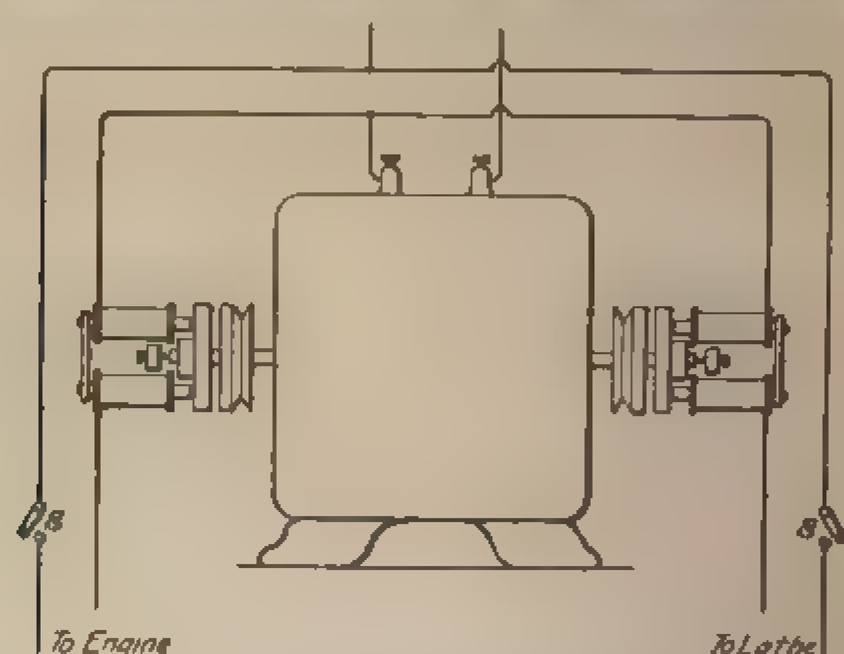

FIG. 41
Diagrammatic Illustration of Method of Wiring for Laboratory and Operating Rooms

the wiring must be so made that when using the switchboard the pulley wheel for that side only is affected. This may be done in the manner illustrated in Fig. 41.

In this diagram S represents the foot-switch in the operating-room and also the switch in the laboratory.

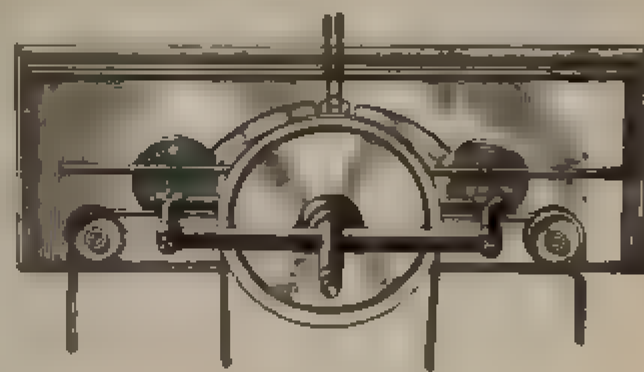

FIG. 42.
Mason Speed Regulator.

134. The Mason Speed Regulator.—The Mason engine was one of the first mechanical appliances for obtaining a variable speed from a motor running at a uniform speed. This device, which is shown in Fig. 42, consists of a large disk, which may be operated by an electric motor. For this reason the Mason system has been of special value where only the alternating current can be had. A friction wheel that also serves as the pulley wheel for the belt is mounted upon a shaft that plays back and forth in front of the disk. In either extreme right or left position the speed is the highest, and this gradually decreases as the friction wheel approaches the center, where it comes to a full stop. It then reverses its direction when passing to the other side of the disk. In this simple manner the operator, by using a lever under the chair, has complete control over the speed of the engine as well as the direction of rotation. The

FIG. 43.
Ritter Engine for Alternating Current.

appliance is also provided with a switch that automatically opens the circuit when the lever is in the middle position and closes it when the lever leaves the center.

135. The Ritter Engine for Alternating Current. All the foregoing engines, except the one illustrated in Fig. 37

FIG. 44
Motor and Lathe Head

and the Mason engine, are to be operated by the direct current. Up to the year 1899 there was no dental motor that could be satisfactorily operated upon the alternating current. In that

year the Ritter Dental Company brought out a motor for this current which can be controlled, and which is in nearly every respect equal to the direct-current motor. This, as shown in Fig. 43, differs but little in appearance from the direct-current engine of Fig. 29

ELECTRIC LATHES.

TYPES OF LATHES.

136. Closely following the introduction of the electric motor in the operating-room, it was adapted for laboratory use. One of the first for this purpose is shown in Fig. 44. This was a most natural transition. It made use of the lathe heads then in use, and simply supplied motive power for what had before required considerable physical effort.

137. The Ritter Electric Lathe.—Although but a few years have passed, there have been a great many changes

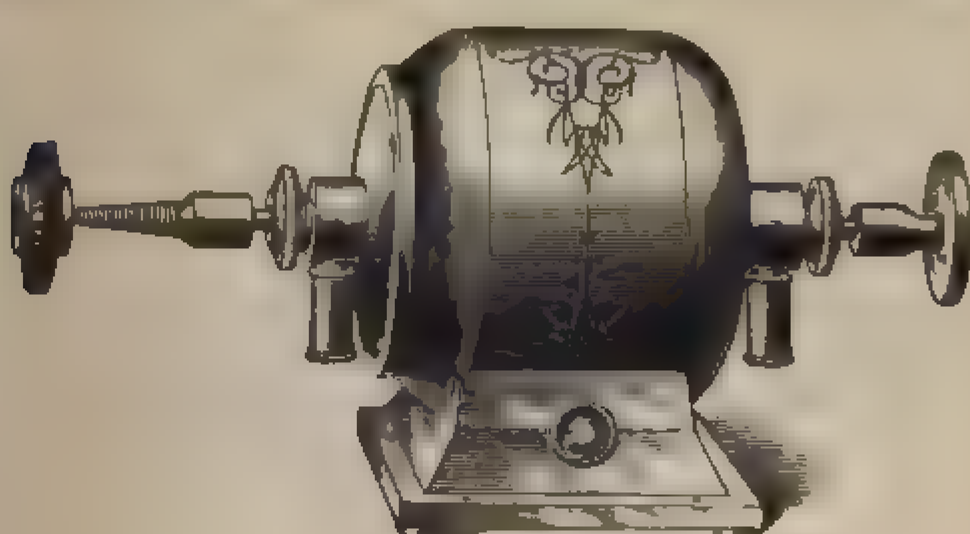

FIG. 45.
Ritter Electric Lathe

in the design and construction of motors for this purpose. The most important change was the construction of a motor and lathe head in one instrument by the Ritter Dental Company. The base of the lathe is made broad enough to stand and be operated wherever it is placed This instrument was an innovation and an ornament to the laboratory, and is so easily portable that many dentists use one motor in both

departments. It is shown in Fig. 45. The field is of laminated iron and is so heavy that when a motor is assembled it will remain perfectly quiet while running. The armature is entirely enclosed, thus making it dust-proof, and both ends of it are fitted to receive the chucks and mandrels. The oil is fed by means of a wick, from a cup below each bearing.

138. Steel Sleeve for Shaft.—A special feature of the Ritter electric motor is the provision for wear. A steel sleeve, shown in Fig. 46, fits upon the armature shaft and is readily replaced by a new one when worn to any appreciable extent.

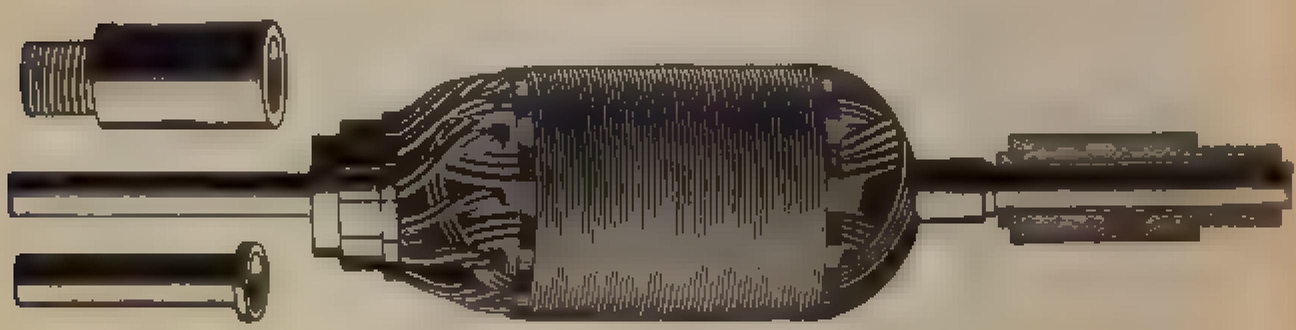

FIG. 46.

Armature and Bearings of Ritter Lathe Motor

This practically makes this instrument one that cannot be worn out in years. A switch button in front regulates the speed of the motor to suit the operator.

139. The Berry Electric Lathe.—The Berry Company makes a lathe motor, as shown in Fig. 47. This is somewhat smaller than the one just described, but is operated in the same manner. It is thoroughly made and is an ornament to the dental office. Both ends of the armature shaft are fitted to receive mandrels, which slip on and lock themselves by a half turn in an opposite direction to that in which the armature revolves. The whole motor is dust-proof, as these motors should be. On the top is a switch for regulating the speed

140. The Browning Electric Lathe.—The Browning Electric Company also has a lathe motor upon the market. This, as shown in Fig. 48, is similar to the first mentioned, in external appearance. It differs from it in point of finish and the method of attaching the mandrels.

141. The Victor Electric Lathe.—The Victor Electric Company manufactures an electric lathe that is shown in Fig. 49. This has the field below and the rheostat above. It has

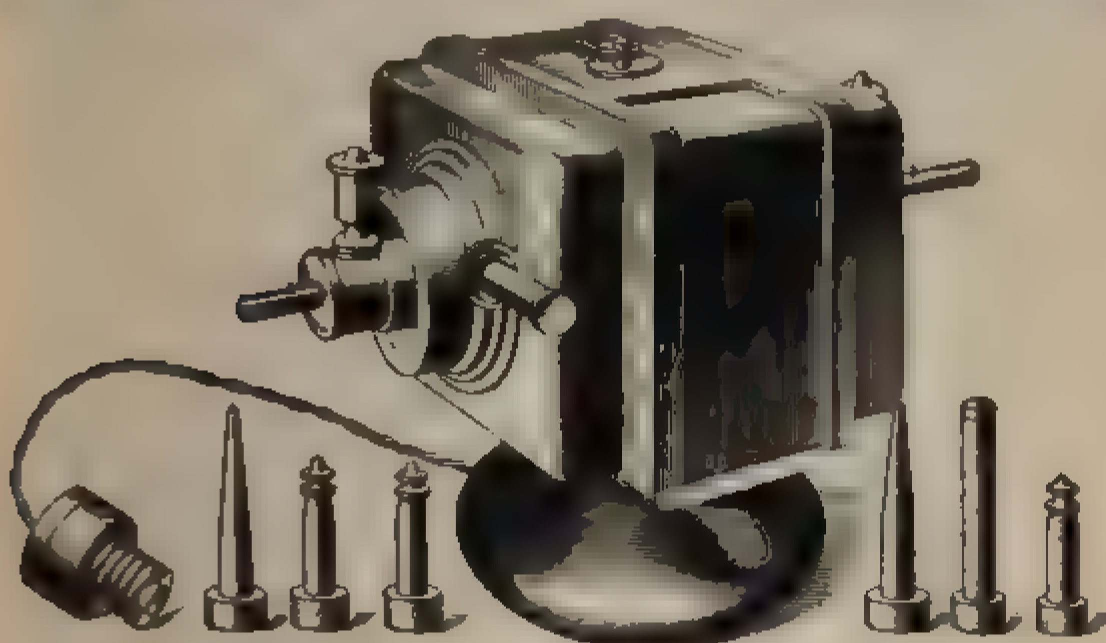

FIG. 47

Berry Electric Lathe.

five speeds and is entirely closed so as to be dust-proof. The mandrels screw directly on the armature shaft by a few turns.

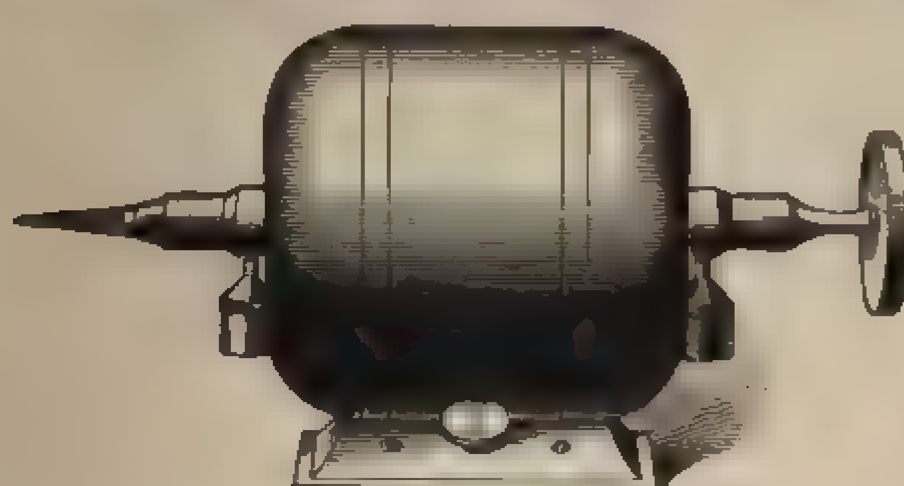

FIG. 48.

Browning Electric Lathe.

This electric lathe is a nominal $\frac{1}{8}$-horsepower, as are, also, nearly all that are designed for this purpose.

142. Motors for Operating Machinist's Lathes. Many of the more fully equipped dental laboratories have a

machinist's lathe. Even the smallest of these lathes require considerable physical strength to operate them, and it is not practical to even attempt to operate the second or third of the smaller sizes by foot-power.

Here the value of an electric motor comes into play, and it will not require as large a one as might be supposed. A No. 4½

FIG. 49.
Victor Electric Lathe.

Barnes lathe, or any of the smaller sizes of machine lathes, can be operated with a $\frac{1}{8}$-horsepower motor. This size is ample for the above-mentioned lathe, and with this as an example, the dentist can readily estimate the size of motor that will be necessary for larger lathes

143. Best Method of Installing Motor and Lathe. The motor should be placed on a bracket back of the pulley,

and not more than a foot distant therefrom. It is a good plan to fasten a shelf, about 18 inches wide, to the back of the lathe bed for the tools, and to set the motor on this. The motor should slide upon its base, for the purpose of tightening the belt. It should also be placed with its pulley wheel to the right in order that it may not interfere with the lathe work. It will be found that if the pulley is put in line with the large end of the lathe pulley and belted thereto, the speed of the lathe will be fast enough. Here comes in play the especial fitness of individual motors for lathe work. In machine shops it is necessary to shift the belt upon the cone pulley of the lathe in order to increase or reduce its speed. This is quite unnecessary when an individual motor is used to operate the lathe. The rheostat not only does this, but it gives a greater range of speed than can be obtained from any other source. Moreover, by the use of a reversing switch, the lathe can be made to run in either direction, a feature not usually found in machine shops except on special lathes.

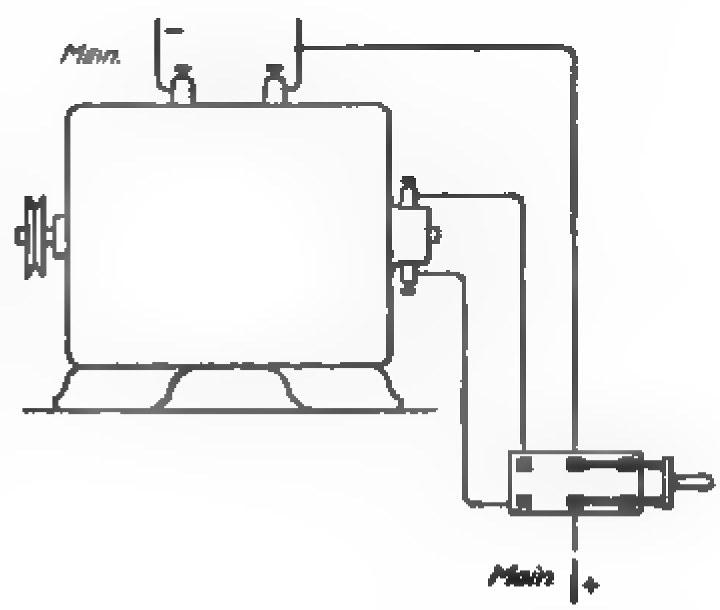

FIG. 50.
Reversing Switch for Series-Wound Motor.

144. The Rheostat Used as a Switch.—It is a good plan always to have the first button of a rheostat blank, as by so doing the rheostat also answers for a switch. The operator knows what speed he will require for the work in hand, and the lever is put upon that button at once.

145. A Reversing Switch for Shunt-Wound Motor. If the motor is not provided with a reversing switch, one can be made in the following manner: A double-pole, double-throw, baby-knife switch can be had at any electrical supply

house. This should be mounted at any convenient place. If the motor is near the lathe head, as suggested, it should be fixed on top of the motor. It should be connected to the motor wires in the manner illustrated in Fig. 50, if a series-wound motor, or as in Fig. 51, if a shunt-wound motor. When the lever is thrown to the right, the current is made to flow through the armature in one direction, and when the lever is thrown to the left, it flows in an opposite direction, the effect of which is to reverse the direction of rotation.

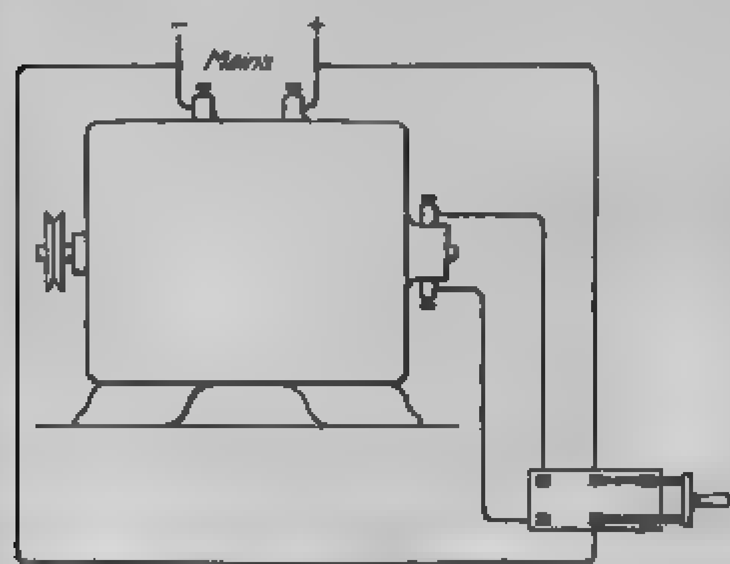

FIG. 51.
Reversing Switch for Shunt-Wound Motor.

It will be noticed that before using the switch two wires should be crossed and connected to the four corner-posts, as represented. They should be placed underneath, and insulated from one another and from the motor.

THE ELECTRIC FAN.

146. The **electric fan** is a welcome adjunct to the dental office, and its value is so apparent that its merits need not be elaborated upon.

147. Type of Fan for Dental Purposes.—Experience, however, has shown that every fan will not answer for the chair. It should be of the buzz-fan type, as shown in Fig. 52. Many dentists make the mistake of using a small fan at a very high rate of speed. Such a fan, to be effective, creates a great deal of noise, and sends out a stiff breeze of rather small field. This is not the most desirable. All that is necessary for the comfort of both patient and operator is a gentle breeze of a wide field. The noise of the small fan, although in a measure one that is soon unnoticed, keeps one in a seminervous tension.

The proper fan for the dental chair would be one at least 15 inches in diameter, and an 18-inch fan would be ideal. It should be operated at such a speed that there will be absolutely no noise. This will usually give a gentle breeze that will not, in the course of the operation, endanger one's health, and yet keep both operator and patient perfectly comfortable. If the dentist will buy a nominal 12-inch fan motor, and use an 18-inch fan thereon, he will have the ideal fan for the dental chair. The motor, in driving the 18-inch fan, may become a little warmer than was intended, but it will not become dangerously so. The motor will have power enough to operate the fan at the speed indicated above, and frequently will have a margin to spare. This can be regulated to suit the operator by means of the rheostat, which is usually enclosed in the base of the fan.

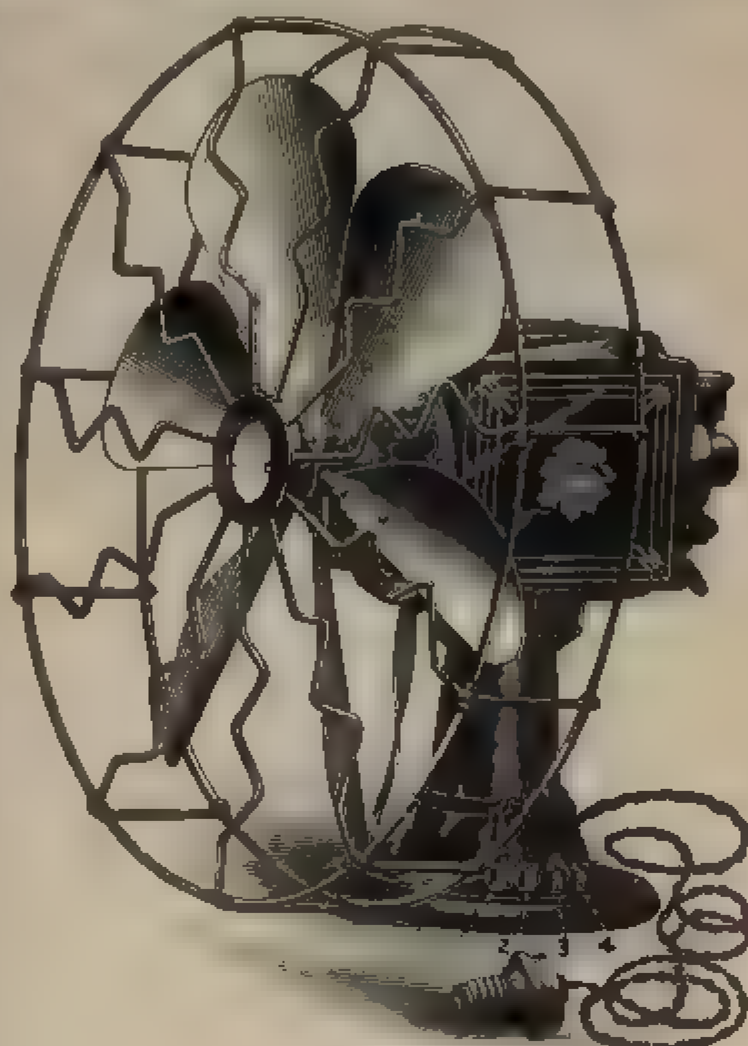

FIG. 52.
Electric Fan

ELECTRIC AIR-COMPRESSORS.

148. The use of compressed air has become a necessity in the well-regulated dental office There are several operations at the chair that can be better performed by air that comes direct from a cylinder under uniform pressure, than by the use of the chip-blower. The desiccation of dentin, the drying of

roots for filling and for setting crowns, the exploration for tartar, and for use with the atomizer, requires a uniform and,

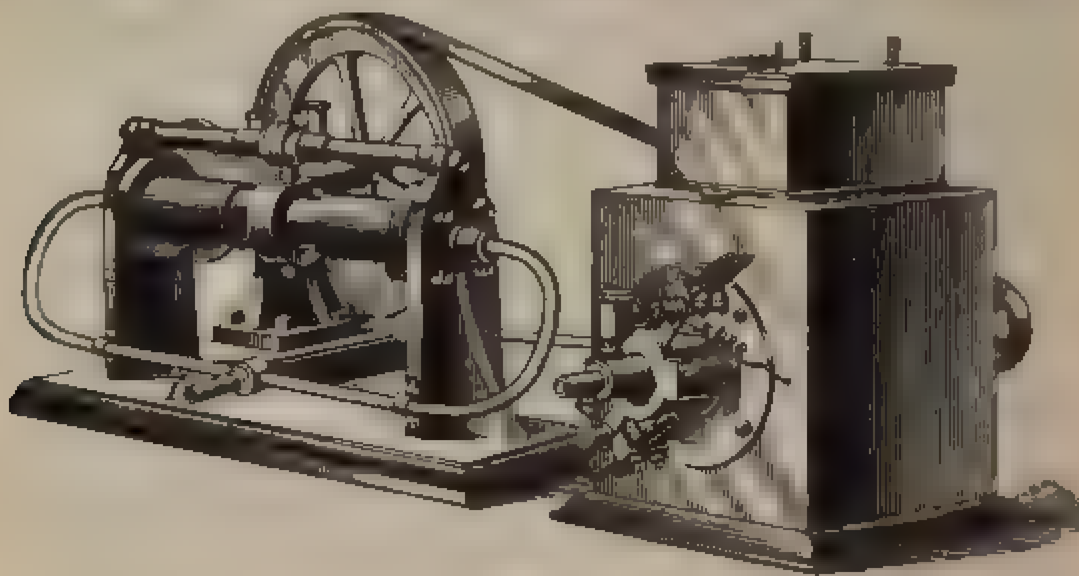

FIG 53.
Victor Air-Compressor No. 1

FIG 54
Victor Air-Compressor No 2.

frequently, a high pressure of air. This can only be had from a cylinder of compressed air. Moreover, its utility often depends largely on its being ready for use at any moment.

149. The Victor Air-Compressor. – Compressed air has usually been obtained where running water is in the building, by the use of a beer-pump. In offices in very high buildings, however, the pressure is not sufficient, and in suburban situations water-pressure is not to be had at all To meet these conditions the Victor air-compressor, as illustrated in Fig. 53, has been devised. This consists of an electric motor and an air-pump mounted together In connection with this, a kitchen tank of at least 60 gallons capacity

should be used as a reservoir It is not practicable to operate the pump every time air is needed; moreover, some blow-pipe operations require a larger volume of air than the pump can supply. By the use of the reservoir, however, the stored-up supply, in addition to the feeding in by the pump, will be sufficient to meet all the requirements. The Victor company also supplies an air-compressor of an upright type, as shown in Fig. 54. This pump is a single-acting machine and will maintain a pressure of 60 pounds in the reservoir.

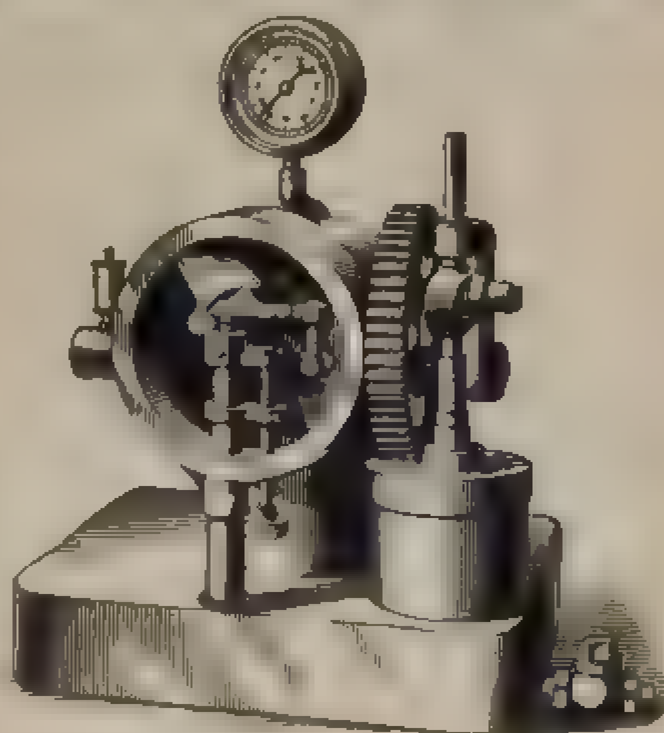

FIG. 55.
Auto-Electric Air-Compressor.

150. The Auto-Electric Air-Compressor.—The auto-electric air compressor takes its name from the automatic working of the device. An electric motor is directly geared to a short-stroke pump. This furnishes an air pressure of 45 pounds. The unique feature of the appliance is the use of an electric device whereby the motor is automatically operated by a slight variation in the air pressure The controlling device can be set so as to operate at any desired pressure up to 45 pounds.

151. Means of Securing Automatic Operation of Motor.—In the practical operation of the air-pump, unless it is of the automatic type, it is necessary to run the motor each morning for the day's supply The ingenious dentist, however, can easily construct a device for automatically operating any electric motor in a manner similar to the auto-electric air-compressor by the lowering of the air pressure in the tank. This can be done by using a cylinder about 3 inches in diameter

covered with a top of corrugated German silver, about No. 32 gage. This acts as a diaphragm that moves up and down with the air pressure. A spring-controlled lever bears upon the center of the diaphragm, and this lever is so connected that it closes the electric circuit and starts the motor when the pressure falls to a certain point. As the diaphragm rises under the increased pressure, the lever is carried away from the contact, breaking the electric circuit when the air pressure reaches the desired point. In this manner the whole outfit can be made automatic, and the cut-out can be so closely adjusted by means of a screw that a difference of but one pound will start the motor.

THE ELECTRIC MALLET.

152. All the foregoing manifestations of power are due to the motive power of an electric motor, in which the central figure is an electromagnet, the field of the motor, which causes another electromagnet, the armature, to revolve. We now take up another electrical instrument in dental practice under the head of power, namely, the *electric mallet*. In this instrument we have practically the same principles at work as in the electric motor, the only difference being that the armature is given a vibratory instead of rotary, motion. The armature in some electric mallets, instead of being an electro-armature, by which is meant one whose magnetism is induced by a coil of wire carrying current around it, is a soft-iron armature. An electromagnetic armature may be used for this purpose, but the requirements are not so great but that the simple soft-iron armature answers the purpose in most electric mallets.

153. The First Electric Mallet.—The invention of the electric mallet by Dr. W. G. A. Bonwill, in 1867, may be said to mark the beginning of the use of electricity in dentistry. The electric current had been employed with questionable results for anesthetic purposes prior to this time, but it was this instrument that introduced electricity in a practical and useful form to the dentist.

154. Superior Qualities of Electric Mallet.—The electric mallet has properties not possessed by any other mallet.

The blow, which can be regulated for any intensity, is practically the same as long as desired. A filling made in this way is more homogeneous than that produced by any other method. The automatic mallet, while similar to the electric, in some respects, gives a blow that is easily modified by the hand either by a little side pressure on the instrument, or by following up the blow with hand pressure, as one is likely to do when using this form of mallet. The same may be said of the electric mallet to a certain extent, but if the plugger is handled so as to simply play over the surface of the gold, as it is possible to do, and the electro-mallet is allowed to do its work, the filling will be of the same density throughout.

155. Rapidity of Blows of the Electric Mallet.—A second feature of the electric mallet is the rapidity of its blows. Gold can be condensed by one heavy blow, and it can be just as well condensed by a number of light blows. The blow of the electric mallet is ordinarily much lighter than from a hand mallet. For this reason the electric mallet can be used upon thin walls that would not withstand the average blow from a hand mallet. Moreover, the blows flowing so rapidly in succession, the plugger point may be moved about over the surface much as one would use a pencil, with the assurance that the area covered by it will receive several blows while so covered. It is unnecessary to set down the plugger by a direct effort, unless especial attention is given to a certain point. The speed of the electric mallet in condensing gold is due to the rapidity of its blows. In large fillings that are easily accessible the electric mallet in a skilful hand will condense the gold as rapidly as the assistant can place it in position. The wonderful operations of Marshall Webb were due to the electric mallet in a skilled hand.

156. Pain From Electric Mallet Less Than That of Hand Mallet.—Some people cannot withstand the blow of a hand mallet, especially if the tooth is somewhat sensitive to pressure. The electric mallet can be frequently used in these cases to an advantage. It should not be understood by this that the electric mallet is without pain, but the peculiarity

of its blow is quite acceptable to some people and disagreeable to others. Generally, however, the electric mallet can be used with less pain on teeth sore to the touch than the hand mallet.

157. Length of Time Shortened by Electric Mallet. The electric mallet is not one that has an universal application, but one that is especially useful in large and accessible cavities. When used in these instances by a skilful hand, it will shorten the time at least one-third, and at the same time give a very dense and even surface for finishing. Such a surface will be without pits and will retain a high polish.

FIG. 56.
Bonwill Electric Mallet

158. Description of Bonwill Electric Mallet.—The first electric mallet, as above referred to, is shown in Fig. 56. This consists of a hollow handle, to the upper end of which is stationed a pair of electromagnets. The armature upon the top is of soft iron and weighted at its vibrating end. The handle is of vulcanite and is made hollow its entire length to receive the plugger. This differs from mechanical mallets in that the plugger handle and point complete is received in the rubber handle, so that the same plugger may also be used with the hand mallet. The plugger used in the electric mallet has a constriction near the point, which, when the plugger is slipped in the vulcanite handle, receives two diametrically opposite springs. These springs hold the plugger in the handle, and at the same time permit of slight movement upon impact of the armature. The length of the

handle is so precise that when the armature is attracted by the magnets, it moves but $\frac{1}{8}$ inch at its free end to deliver its blow upon the plugger handle, and yet, in the latter part of this movement, and when about to strike the plugger, it automatically breaks the current. An inspection of the mallet will show that it is operated upon precisely the same principle as an electric bell, except that the current is broken more suddenly. When the armature is at its greatest velocity it strikes the circuit-breaking spring, at a point of advantage. Ordinary bell vibrators simply leave a contact point that follows the armature a short distance by the flexibility of the spring that supports the contact.

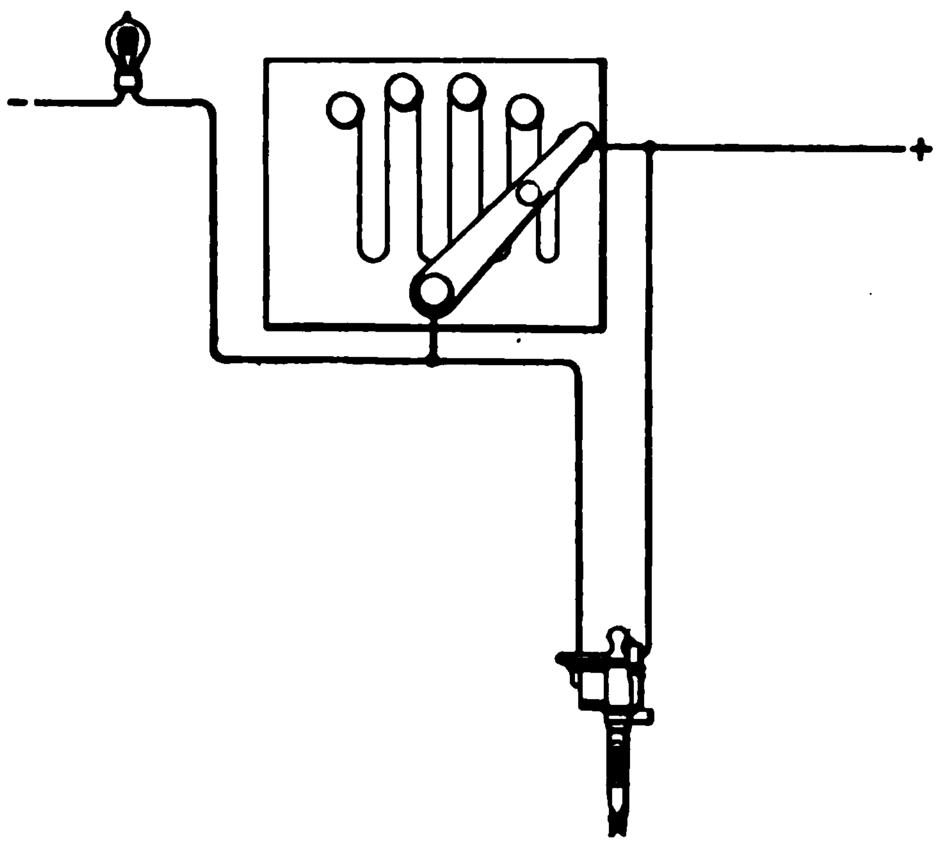

FIG. 57.
Electric Mallet on 110-Volt Current.

159. Current Necessary to Operate Bonwill Electric Mallet.—The Bonwill mallet, while intended orignally as a battery instrument, can, with proper care, be operated by the commercial 110-volt current. In so doing, the greatest care must be exercised in insulating the wires of the plugger from the metal work, and, also, as a further precaution, to insulate the chair from any gas-pipe or water-pipe.

160. Construction of Rheostat.—If it be desired to use a former battery mallet upon the 110-volt current without rewinding the magnets, the procedure should be as follows: Use a 50-candlepower lamp as a main resistance, and in series with that insert about 30 feet of No. 24 gage German silver wire, wound on slate and placed in a resistance-box with about six buttons. Then connect the plunger so as to be in shunt

with this resistance, as diagrammatically shown in Fig. 57. By so doing, there will be no destructive spark, as there would be if the mallet were placed with the main resistance without a shunt resistance. In the operation of the rheostat, as shown diagrammatically in the figure, moving the lever to the left increases the blow of the mallet and to the right decreases it.

If the magnets were to be rewound with No. 34 silk insulated wire, a 32-candlepower lamp on each side of the rheostat and plugger would give the proper resistance, and at the same time protect the patient from a heavy shock in case of accidental grounding.

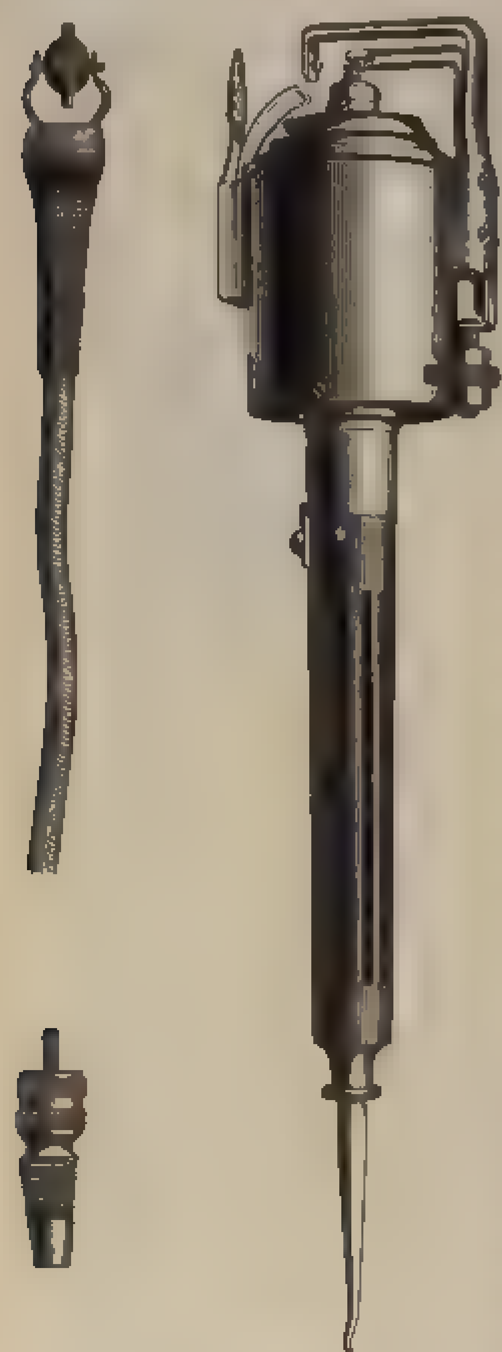

FIG. 58.
Barnes-Skinner Electric Mallet

161. Electric Mallet to be Operated by Alternating Current. The S. S. White Company also supplies an electric mallet of the Bonwill pattern, to be operated by an alternating current. This current is derived from a motor generator especially designed for the purpose, and shown in Fig. 34. The motor part is intended for driving a dental engine, and the dynamo for operating the electric mallet and other small electric appliances.

162. Gibbs Electric Mallet. About the year 1890 an instrument under the name of the *Gibbs electric mallet* appeared upon the market, but for some reason this never came into general use. It was ingenious and simple. The handle was

hollow and contained one electromagnet, which was fixed in the lower end. In the upper end was a soft-iron plugger that was drawn toward the electromagnet on closing the circuit. In so doing it struck the end of a plugger, which was movable through the center of the electromagnet. This plugger is very convenient to handle, inasmuch as it is perfectly round and is not weighted at its upper end, as is the Bonwill.

163. The Barnes-Skinner Electric Mallet.—The Barnes-Skinner electric mallet, as shown in Fig. 58, is a compromise between the Bonwill and the Gibbs, and also has

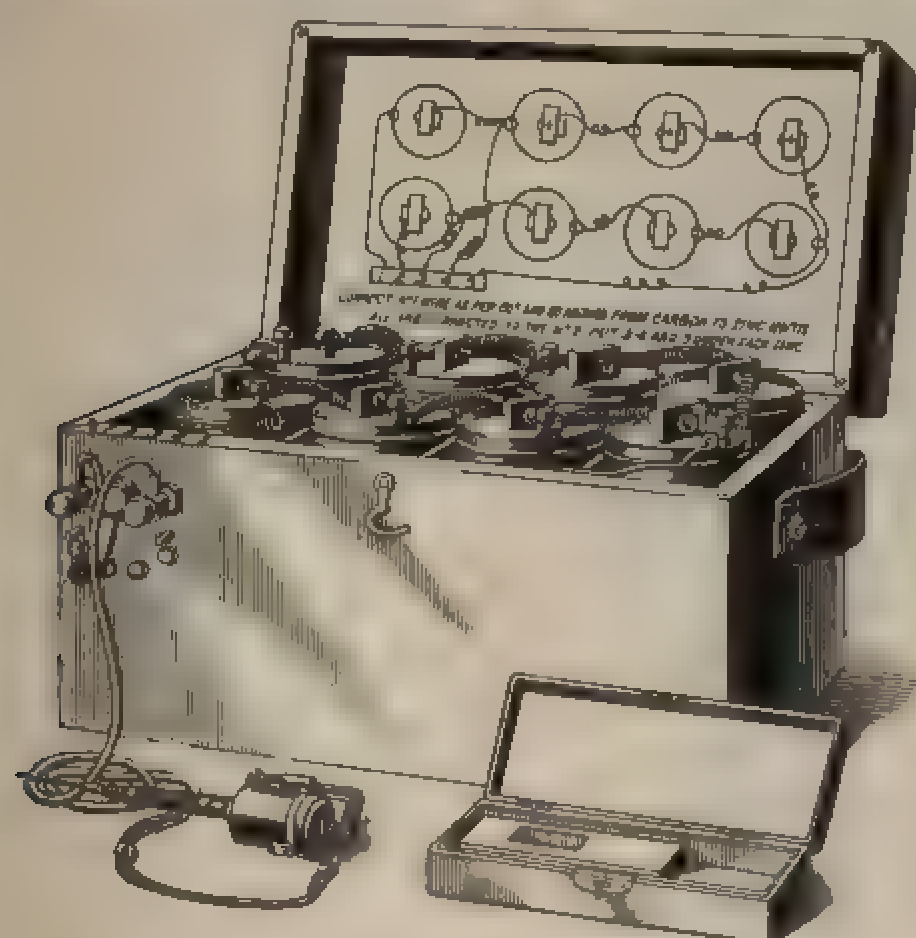

Fig. 58

Barnes-Skinner Mallet With Battery Outfit

features not possessed by either. But one electromagnet is used in its construction. This is seen at the top. Still beyond this, as a cap to the instrument, is a soft-iron armature that has the mallet function. In this respect it resembles the Gibbs in principle, but it is an improvement in that the mallet is free to move without any side friction of consequence. In the

Gibbs the friction of the movable part upon the sides of the casement will at times affect the blow, unless the operator will humor its peculiarities.

164. Battery Outfit.—The Barnes-Skinner mallet is wound for battery use, which we would always recommend for the electric plugger because of its safety from shocks. Such an outfit is shown in Fig. 59.

FIG. 60.
Barnes-Skinner Mallet for 110-Volt Current

165. 110-Volt Current Outfit.—When the instrument is to be used on the 110-volt current, a main-resistance lamp is used, and the mallet is operated in shunt with another resistance, which is furnished in the rheostat. This is shown in Fig. 60.

166. Precautions Necessary When Using 110-Volt Current.—Too much cannot be said as to the importance of insulating the patient and the chair from water-pipes and gas-pipes when electrical instruments are to be operated by a commercial current. While there is not much danger of a fatal shock from any commercial current used for incandescent lighting, there is always danger of an unpleasant one. The shock that may be received from the 110-volt constant current or the 104-volt alternating current is even unpleasant when connection is accidentally made by the hand, but it is much more so if the current is received through other parts of the body. The lips and teeth are nearly always wet, and they furnish the best of

conditions for making an electrical connection. They are, moreover, especially sensitive to electric currents. While the commercial currents of even the lowest voltage demands careful insulation of the patient from any possible grounding, this precaution is still more important when using the 220-, or 500-volt current at the chair. There may be no direct metallic connection between the metal work of the chair and the water-pipes, but the column of water in the rubber tube that connects the pipes with the fountain cuspidor has sufficient carrying capacity to supply the conditions for an electrical ground. It is the practice of some operators to burn gas instead of alcohol at the chair, and to conduct the same thereto by means of metal tubing. The possibility of accidental grounding through this source should also be provided against. It is a simple matter to insulate the chair from gas-pipes and water-pipes, and a set of fiber bushings should be used at the fastening of the fountain cuspidor to the chair.

ELECTROLYSIS.

INTRODUCTION.

167. Discovery of Electrolytic Action of Direct Current.—In May, 1800, Nicholson and Carlisle, while experimenting with the direct current, which at that time was quite new, discovered that if the same was passed through a vessel of water, the water would be decomposed. This phenomenon was taken up by Davy, who not only made a further study of it, but turned it to practical use. In 1807, he succeeded in decomposing the so-called "fixed alkalies," whose composition up to that time had been unknown. He obtained metallic potassium from pure potash by electrolysis, and by a similar process soon after, he obtained sodium, barium, strontium, calcium, and magnesium.

168. Some Electrical Laws Known in 1806.—At this early date the laws governing electrolysis were noticed, for in 1806, Volta, in referring to the decomposition of water,

speaks of the oxygen as appearing at the positive pole, while hydrogen appeared at the negative pole.

169. Electrolysis Defined.—The term *electrolysis* has reference to chemical changes that occur when an electric current passes through a conductor of the second class; that is, a conductor that is a chemical compound either in a fused state or in the form of a solution. The essential conditions permitting electrolytic action are a compound substance and a state of fluidity. Grotthuss supposes that the molecules of a solution are in a constant state of vibration in all possible directions. This condition cannot be present without occasional collisions between the molecules, at which time and under certain conditions, as the influence of an electric current, there may be a change of partners. Every molecule has an inherent electrical charge that is divided in itself into positive and negative, residing in their respective groups called *ions*. When a difference of potential is sufficiently strong at the electrodes, the ions separate from the molecule in which they are first found and travel toward the pole for which they have an affinity. Those traveling toward the anode are called *anions*, and those traveling toward the cathode are called *cations*. It is in this manner that a liquid conducts a current, and this is illustrated in a traffic over a bridge. Wagons going in one direction carry merchandise of one kind, while those going in the opposite direction carry merchandise of another kind.

ARRHENIUS ION THEORY.

170. Arrhenius, in 1887, gave out his theory of the electrolytic dissociation of ions. He maintained "that the molecules in aqueous solutions are already dissociated into two ions, which are loaded with their respective electric charges", that "electrolysis does not therefore require the previous splitting of the molecule by the electric current." This seems to be the principal point of difference between the two theories. Arrhenius further stated, also, that the passage of a current through an electrolyte is due to the free ions, and those molecules that have not divided themselves into ions, if there are any, take no part in the process. It has long been known that chemically

pure water is not an electrolyte, but the addition of the smallest quantity of impurities makes it one. This is accounted for by supposing that the hydrogen and oxygen have not ionized, a condition that is easily produced when an impurity is added. Nor is water the only simple electrolyte, which, when absolutely pure, will not conduct a current. Chemically pure, or 100 per cent., sulfuric acid will not conduct an electric current, and yet, when diluted with water until it is about a 25-per-cent. solution of sulfuric acid in water, it becomes one of the best liquid conductors. The water in this case must therefore be regarded as an agent that is capable of separating the molecules into ions.

171. Action of Ions Demonstrated in Electroplating.—When the ions have reached the electrodes for which they started they deliver their electric charges and accumulate at that electrode. If there is any possible affinity between the two, a union is effected, and we have an illustration of what takes place in the well-known process of *electroplating;* if there is no affinity, the ion appears in the form of a gas or as a precipitate, as the case may be. In the electrolytic decomposition of copper sulfate, for instance, it is first separated into copper, the electropositive ion, and into sulfion SO_4, the electronegative ion. The copper moves toward the negative electrode and the sulfion toward the positive electrode. If the negative pole is in a condition to receive the copper, and the process is not too vigorous, the copper attaches to the electrode in the form of a metallic precipitate, sufficiently firm to remain and fine enough to receive a polish. The sulfion, on the other hand, upon reaching the positive pole unites with the water forming sulfuric acid and liberating the surplus oxygen, which escapes from the solution in the form of gas. If the positive electrode is of copper, the sulfuric acid that is formed at this pole unites with the copper, forming copper sulfate, which being soluble in the water is dissolved, thus keeping the electrolytic solution in a state of equilibrium. As fast as copper is taken from the solution and deposited upon the negative electrode, copper is added to the solution by the electrochemical process going on at the other electrode.

172. Rearrangement of Ions.—There is therefore as a first step in electrolysis, a selection of partners, which have been termed ions Whether these arrangements are always mutually understood in the molecules or are the result of an electrical disturbance created by the current, is still a matter of speculation. These ions, however, arrange themselves in order, according to their electrical affinities, and move toward their respective electrodes; the anions toward the anode and the cations toward the cathode. In the formation of the ions the electropositive elements form one group and the electronegative elements form another, making these selections according to the following table of electrochemical properties by Berzilius:

POSITIVE END.

Name.	Symbol.
Cæsium	*Cs.*
Rubidium	*Rb.*
Potassium	*K.*
Sodium	*Na.*
Lithium	*L.*
Barium	*Ba.*
Strontium	*Sr.*
Calcium	*Ca.*
Magnesium	*Mg.*
Glucinum	*Gl.*
Aluminum	*Al.*
Zirconium	*Zr.*
Cadmium	*Cd.*
Manganese	*Mn.*
Zinc	*Zn.*
Iron	*Fe.*
Nickel	*Ni.*
Cobalt	*Co.*
Cerium	*Ce.*
Lead	*Pb.*
Tin	*Sn.*
Bismuth	*Bi.*
Uranium	*U.*
Copper	*Cu.*
Silver	*Ag.*
Mercury	*Hg.*
Palladium	*Pd.*

Name.	Symbol.
Rhodium	*Rh.*
Platinum	*Pt.*
Iridium	*Ir.*
Osmium	*Os.*
Gold	*Au.*
Hydrogen	*H.*
Silicon	*Si.*
Titanium	*Ti.*
Tantalum	*Ta.*
Tellurium	*Te.*
Antimony	*Sb.*
Carbon	*C.*
Boron	*B.*
Tungsten	*W.*
Molybdenum	*Mo.*
Vanadium	*V.*
Chromium	*Cr.*
Arsenic	*As.*
Phosphorus	*P.*
Selenium	*Se.*
Iodin	*I.*
Bromin	*Br.*
Chlorin	*Cl.*
Fluorin	*F.*
Nitrogen	*N.*
Sulfur	*S.*
Oxygen	*O.*

NEGATIVE END.

173. Simple Electrolysis Compared With Electrolytic Action of Batteries.—Every battery depends for its action on electrolysis. In this instance, the chemical processes that go on in the battery when the external circuit is closed cause a liberation of the electrical charges of the ions, and we have the manifestation of a current flowing in the external circuit. In battery action, the conditions being favorable, the molecules of the electrolyte dissociate themselves, and deliver their electrical charges of their own accord; in simple electrolysis, under the influence of an electric current, we have the ions carrying their charges toward their respective electrodes. While the two processes are identical from an electrolytic point of view, we have this marked difference: the one is produced by energy from within and the other by energy from without.

174. Electrolytic Processes in Organic Matter. Electrolysis is an active agent in nature's laboratory. Many of her processes in the life and growth of animal and vegetable organism, as well as in the reduction of the same, are carried on by electrolysis. Electric currents are developed with the chemic processes, and these in turn produce other changes, which go on in the building up and in the tearing down of all organic matter.

175. Electrolysis as a Destructive Agent.—Electrolysis is of a high value, commercially, when used in electroplating, and at the same time if not guarded against it becomes a very destructive agent in our cities. Current easily escapes from the car lines, and, finding good return by way of the water- and gas-mains, dissolves these at the point of leaving. In this day, when we are surrounded on every side by the commercial applications of electricity, the escape of the fluid into the earth, especially in the cities, and the destructive effect on the gas- and water-mains becomes a perplexing problem for the engineer. This condition is most noticeable in cities operating electric cars that provide for the return circuit through the rails. This circuit, by bad connection, often offers so much resistance that the current finds a path of less resistance through the water- and gas-pipes, which may be lying near by. In the

course of time these pipes will be found to be badly corroded by the electrolytic action of the current.

176. Therapeutic and Commercial Uses of Electrolysis.—While electrolysis may thus become a menace, when a heavy current is allowed to escape, it, however, has electrotherapeutic and commercial uses that make this property of the electric current one of the most useful in medicine and in the arts.

All animal tissues provide the conditions for and are subject to electrolytic action. Albumen is coagulated, water is decomposed into acids and bases. In this process, although an animal tissue, the laws of electrolysis are the same that operate in the galvanic cell; the acids and oxygen appear at the positive pole, and the alkalies and hydrogen appear at the negative pole. This phenomenon is put into practical use by the electrotherapeutist in two ways: One, by the liberation of a nascent salt, by the solution of the electrode itself, and the other, by a decomposition of the tissue with which the electrode is in contact. If the positive electrode is composed of zinc, the chlorin that forms at this pole will attack the zinc, forming zinc chlorid, a strong caustic. Or, if the negative electrode is composed of platinum, which is not dissolved by the current, then the underlying tissues undergo decomposition and are destroyed by the agents that form at this pole. Potassium, sodium, and other electropositive elements that may be contained in the tissues form at the negative pole and cause destruction of the tissue by their caustic action. While it seems that the loss of tissue in these instances is more largely due to the destructive agency of the products formed, there is loss, also, of tissue in the first step of the process that gave up these salts.

Electrolysis is a therapeutic agent of unquestioned utility in the treatment of aneurism, cystic tumors, goiter, nasal polypi, nævi, sebaceous tumors, stricture of mucous canals, hydrocele, and the like. In some of these lesions this method of treatment gives results that are even more satisfactory than the methods of treatment by surgical operation or by the use of medicinal agents that promote absorption.

177. Application of Electrolysis in Dentistry. Electrolytic treatment has also found applications in dental therapeutics. In 1884, Dr. W. V. B. Ames used a weak galvanic current in the treatment of pyorrhea alveolaris. He decomposed the contents of the pockets, getting nascent oxygen and chlorin in addition to the stimulating effect of the current. Medicinal agents were also used; iodid of potassium, when decomposed in the pocket, liberated nascent iodin at the seat of pus formation.

178. Necessary Apparatus. — The requirements for electrolytic medication do not differ much from those in cataphoresis, as will be described later. The battery, or whatever may be the source of current, need not give a pressure of more than 25 volts. The rheostat should be one that has at least five steps to the volt. A cataphoric rheostat makes an ideal instrument for this purpose. A milliammeter should always be used in the work. This should read as high as 40 milliamperes, which may be reached in some cases, depending on the voltage and the area of exposed tissue.

ELECTROPLATING.

179. Various Uses of Electroplating.—While electrolysis is largely used in the arts, in the manufacture of chemicals, and in metallurgy, its largest field is in electroplating. Nearly every instrument we see about us, every piece of shining metal, and many ornaments that beautify our homes and offices, owe their luster and finish to the plater's bath. Not only this, but nearly every paper that is printed, and every book that is published, owes its small cost to the electrotype. Electroplating has become an industry in which thousands are engaged, and the process has been simplified to such an extent that the amateur can carry on the process at home.

180. Electroplating Outfit for Dental Work.—The dentist has frequent use for an electroplating outfit, and although he may be situated within easy reach of a plating establishment, it is often more satisfactory to do the work himself, provided he

has the facilities. The most of his needs are for small work, and in his laboratory equipment will always be found instruments and appliances that may be utilized. As a matter of fact, but little in the way of appliances is required outside of his laboratory equipment, except some of the chemicals used. He has a lathe and buffers, facilities for heating water and plating solutions, and beyond these nothing is necessary except a few chemicals and the plating baths. The different solutions can be made up and sealed in ordinary glass sealing jars, which not only prevent evaporation when not in use, but by reason of their wide mouths make ideal containing vessels at the time of plating.

181. Metal-Plating by Chemical Processes.—While the usual method of electroplating is through the agency of an electric current supplied from without, yet there are metals and solutions in which the simple immersion of the one in the other will cause the precipitation of the metal contained in the solution upon the metal that is immersed. If a piece of clean iron is dipped in a solution of copper sulfate, it will quickly become coated with a covering of copper, and in the same manner iron will receive a deposit if dipped in a solution of chlorid of bismuth, trichlorid of gold, chlorid of platinum, or nitrate of silver. German silver will receive a deposit if dipped in a solution of trichlorid, and also if dipped in gold trichlorid of antimony, or platinum chlorid. Gold trichlorid will, when used as a simple solution for immersion, deposit its gold upon nearly all metals, and in like manner platinum chlorid will, with almost equal facility, deposit its platinum upon other metals. In these reactions there is a chemical interchange of elements.

Electrodeposition may also be accomplished in a single cell; that is, the article to be plated is made one electrode of the cell. This is illustrated in the ordinary Daniell cell, in which the object takes the place of the copper-plate.

182. Superiority of Electrolytic Method.—For commercial purposes, the deposition of metal by means of an

electric current supplied from without gives the best results. With conditions just cited, where the process is principally of a chemical nature, and one that is limited by the local conditions, the deposit is scarcely more than a film, without firmness of adhesion and thickness of body. When an electric current is supplied by a battery, or when a dynamo is used, there is an opportunity to control the rate of deposit, to strengthen the adhesion, to modify the fineness of the deposit, and to control the thickness.

METHODS OF ELECTROPLATING.

183. Current Used for Electroplating.—When an electric current is used, the first essential is that it must be a constant current, such as is derived from a battery, or which is commercially supplied under the name of Edison or direct current. The dentist can also obtain a current for plating purposes by the use of a small shunt-wound dynamo.

The voltage of the current used in electroplating is comparatively low. It is so low that a few voltaic cells will ordinarily furnish all that is necessary for individual purposes. Gold and copper may be deposited from their solutions with a pressure of only ½ volt, and even the solutions most difficult to break up require less than 8 volts to effect their decomposition. For this reason even the most elaborately equipped plating establishments use dynamos that are wound to give no higher than 10 volts. This also covers the resistance of the conducting wires. The dentist's needs are confined to the use of gold, silver, copper, and nickel, and except in the case of the last mentioned, two cells will be all that are necessary. Nickel solutions require from 5 to 6 volts pressure to effect their decomposition and that will necessitate the use of three or four Bunsen cells in series. Or, if the dentist is equipped with the S. S. White battery outfit for operating his electric engine, he can use that for all plating purposes.

184. Method of Utilizing 110-Volt Direct Current. The second and most convenient method of obtaining a current for electroplating, is by the use of a commercial current,

provided that it is already established in the office for other purposes. This, of course, should be the constant or direct current, as it is sometimes called. It is usually supplied at 110 volts pressure, and in order to obtain a current of low voltage from this for plating purposes, it is necessary to construct some form of shunt rheostat.

The dentist may do this in the following manner: Use one 16-candlepower lamp as a main resistance, and in series with that any electrical instrument or rheostat which has from 5 to 15 ohms resistance. If this is done, as shown in Fig. 61, and two wires are connected, one on either side of the second resistance, a current of from 2 to 5 volts will be shunted through the plating circuit. The pressure of the plating will be inversely proportionate to the resistance of the shunting resistance with which it is in parallel. If an electric-light carbon is used as the shunting resistance, about ½ volt pressure will be operative in the plating bath, or by the use of a 16-candlepower lamp as the shunting resistance, as high as 50 volts can be obtained if necessary. In practice, two or three electric-light carbons conveniently mounted in the form of a rheostat will be all that is necessary. Or, the last or second from the last button of any rheostat used for operating a motor or electric oven, will give the proper resistance. A large size electric oven will shunt 2 volts if closed, or 3½ volts, if open.

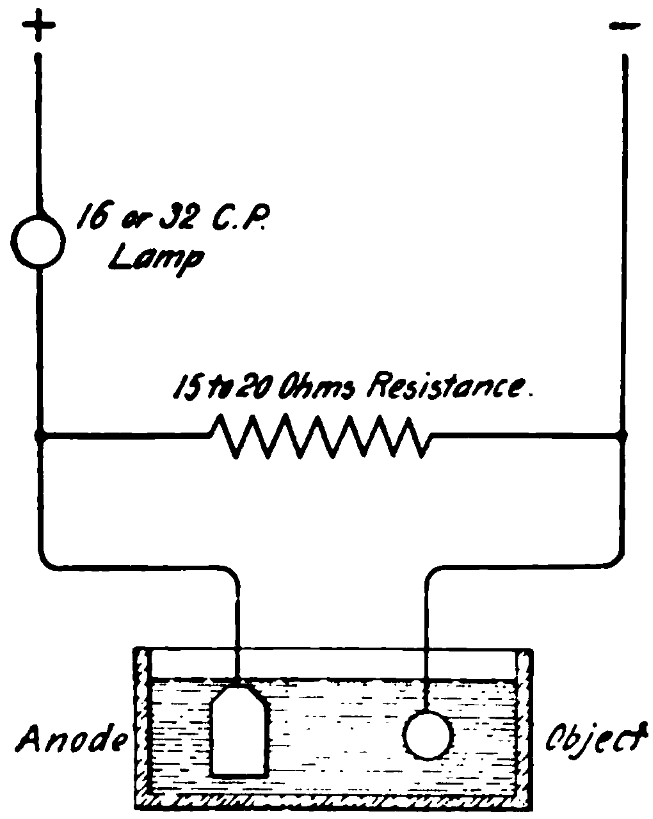

FIG. 61.

Diagrammatic Arrangement of Wiring for Plating on 110-Volt Circuit.

185. Small Dynamo for Electroplating.—The third method for obtaining a current for electroplating is by the use of a small dynamo, as shown in Fig. 62. These, almost as toys, are upon the market for operating small electrical appliances and are designed to be operated by water-power.

Complicated as this may seem, it is entirely feasible. A dynamo for electroplating should be shunt-wound, for the reason that such a dynamo will not change its polarity, should a current pass through it from the plating solution in the reverse direction. A series-wound dynamo will reverse its polarity under the conditions just mentioned, which will prove a constant annoyance. Such a dynamo can be used, however, if the operator is observant and uses a pole changer, by which the direction of current through the solution can be quickly

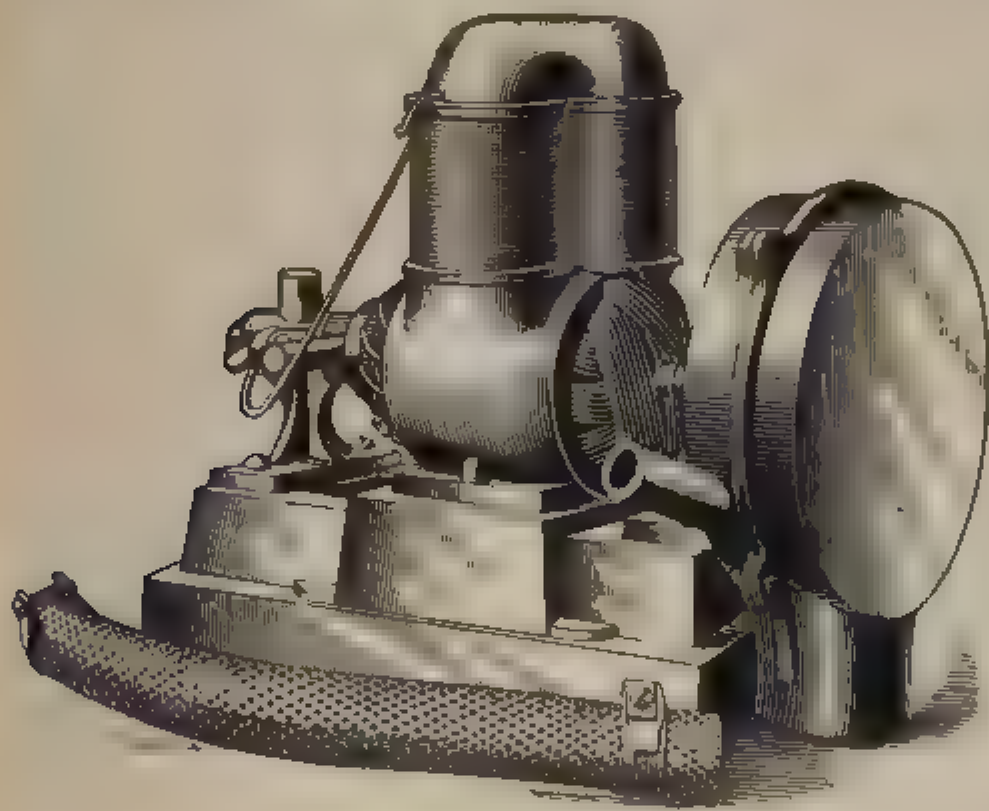

FIG. 62.
Water-Operated Dynamo for Plating

reversed, should the current be flowing in the wrong direction. Any series-wound dynamo, though, can be easily converted into a shunt-wound dynamo by changing the connections. A series-wound dynamo or motor has its field and armature connected in series. A wire will be seen running from one of the brushes to the field. If a new connecting wire is attached to this brush or wire and another is attached to the two binding-posts to which the connections were formerly made, uniting them as one, and these two new wires led out to two

other binding-posts, the dynamo will be what is known as shunt wound, that is, the field and the armature windings are in parallel.

PRECAUTIONS TAKEN IN ELECTROPLATING.

186. Necessity of Cleanliness.—Every step in electroplating requires the utmost cleanliness. The least particle of dust or grease will prevent perfect adhesion of the plating. Cleanliness in electroplating means more than ordinary cleanliness. It means an absolute purity of surface of the metal to be plated. Even handling by the naked hand, however clean, will cause the coating to strip off in time. The surface of the object to be plated must not only be made absolutely clean by chemical means, but as a last step, chemical processes are required before the surface is in condition to receive a coating that will adhere with sufficient tenacity to withstand usage.

187. Care in Finishing Surface of Articles to be Electroplated.—In preparing all articles for plating it should be borne in mind that the finished surface will be the same in point of smoothness that it is before plating.

If the coat of plating is thick enough then when polished all scratches may be obliterated. It is therefore necessary to finish those parts that are to be polished as well before plating as they are expected to be when finished. This can be done upon the dental lathe by the ordinary wheels and buffs used in dressing and polishing vulcanite plates. And, if the dentist enters into electroplating somewhat extensively, he can make excellent buffs by using wooden wheels from 2 to 4 inches in diameter and of various thicknesses, upon the rims of which are glued strips of emery-cloth of the same width as the wheels. New strips are added from time to time, it only being necessary to glue the ends an inch or so.

188. Chemical Preparation of Surface.—When those surfaces that are to be polished have been finished, the next step is the chemical preparation of the surface. Iron and steel, after being highly polished, are passed into a potash bath to

remove any oil or grease that may have been contracted during the polishing. This is made by dissolving ½ pound of caustic potash in a gallon of water, and is to be used hot. If there has been some delay and a film of oxid has formed upon the surface, this can be removed by immersing for a few minutes in a 15-per-cent. solution of hydrochloric acid. It should then be washed in water and immediately placed in the plating bath.

Copper, brass, German silver, bronze, aluminum-bronze, nickel, silver, and several other similar alloys are all prepared alike. The buffing having been done, the piece is placed in the potash bath as prescribed for the treatment of iron. It is then removed and briskly scoured with a stiff brush and pumice to insure the complete removal of the last traces of oil, and also to remove the high polish upon the surface. As a final step before transferring to the plating solution, the piece is dipped into a solution of cyanid of potassium. This is made up of 8 ounces of cyanid of potassium to a gallon of water. It should be kept in an earthenware jar and used cold. When articles are to be gold- or silver-plated, the piece may be dipped into a solution of mercuric nitrate, made by acting upon mercury with nitric acid and diluting, just before placing in the plating bath. In doing this a very thin coating of mercury will cover the surface, which protects it from oxidation and at the same time produces a more receptive surface for the gold or silver.

189. Plating Non-Metallic Articles.—When non-metallic objects are to be plated, they must first have their surfaces made electrical conductors. The most generally adopted plan is the coating of the surface with black lead, or graphite. This material, being in a very fine powder, is dusted upon the surface and worked into every inequality. It is the better plan to first coat this with a plate of copper, and that with whatsoever metal is desired, treating it then as a copper-plate.

In making the connections for plating, the object to be plated is to be connected to the negative wire from the battery or dynamo, and an anode of the same metal used in the plating, connected to the positive wire from the electrical source.

GOLD-PLATING.

190. Current-Strength Necessary for Gold-Plating.—Gold is one of the most easily deposited metals. It will deposit from a trichlorid solution by the simple immersion in it of nearly all metals, and if a current is used, scarcely more than $\frac{1}{2}$ volt is necessary to effect deposition. There is no metal used in electroplating that possesses the many properties of gold. This metal has a wide variety of colors and character of deposit, due to the solution from which it is deposited and the strength of the current used. A solution containing from 1 to 5 pennyweights of gold to the gallon, will give a fine precipitate of pale-yellow color, while a solution very heavy with gold, 15 pennyweights to the gallon, will yield a deposit of gold of a dark-red color. All shades between these can be obtained by modifying the strength of the solution. Then, again, the strength of the current has much to do with the appearance of the deposit. A weak current of $\frac{1}{2}$ volt will produce a deposit of pale, smooth, and closely adherent gold, while a pressure of over 5 volts will cause a deposit of a dark, coarsely crystallin nature. The latter is not firmly attached to the metal and is liable to strip in the burnishing or in subsequent use.

191. Formulas for Gold-Plating.—There are many formulas and methods of preparing a bath for gold-plating. Some are to be heated at the time of plating and others are to be used cold. Dr. H. F. Briggs recommends the following: "Take 30 grains of pure gold and digest in aqua regia; evaporate almost, but not quite, to dryness; dissolve this in 20 ounces of water, then add $\frac{1}{2}$ ounce of cyanid of potassium." The aqua regia of the formula is composed of 3 parts of hydrochloric acid and 1 part of nitric acid. This solution is to be heated to about 150° F., at the time of using.

Very satisfactory results have been obtained by using a cold bath of the following formula:

Chlorid of gold	30 grains.
Cyanid of potassium	60 grains.
Distilled water	1 pint.

The gold of this formula is the same as that used in

photography for toning, and is usually sold in bottles containing 15 grains each. When the solution is made up it should be kept in a glass fruit-jar.

192. Method of Procedure.—The object having been prepared for the bath in the manner previously outlined, it is then to be connected to the negative wire from the battery and a sheet of pure gold-foil, No. 10, or heavier, suspended from the positive wire of the battery. The gold-foil, which now becomes the anode, should be as large or larger than the object to be plated.

The strength of the current being necessarily very little in depositing gold, a single cell will usually be found to be sufficient. A single Edison, Lalande, or Bunsen cell will always give ample current for the dentist's use. Open-circuit cells may also be used, and where the operator has only an occasional use for his electroplating outfit, these will probably be the most satisfactory, For the deposition of gold, only one of these, if in good order, and two at most, will be necessary.

PLATINUM-PLATING.

193. Platinum can only be satisfactorily deposited upon copper and its alloys. Tin, iron, or zinc, can only be imperfectly platinized, even after first coating them with copper. One of the difficulties encountered in plating with platinum is the varying condition of the bath, due to the insolubility of the platinum anode. In plating with gold, silver, or copper, the strength of the solution is maintained by about an equal addition of metal dissolved from the anode by the electrolytic process. In platinum- and iridium-plating, however, the anode is not dissolved and the metal is derived entirely from the solution. The electrolyte is thus being continuously weakened while the deposition is going on.

The second difficulty experienced in platinum-plating is the ease with which it is deposited from its solutions by the simple immersion in it of some metals to be plated, zinc, iron, and tin reduce it simply by immersion. This facility with which the solution is decomposed causes the same condition that is

present when a very heavy electric current is used in plating. It causes the metal to deposit in a loose, black condition, lacking adhesion. It is therefore important in plating with platinum to have the solution rather weak in platinum and to use only a feeble current for precipitating it.

194. Solution for Platinum Bath.—The solution generally used for platinum deposition is the double cyanid of platinum and potassium in distilled water. This is made up in the same manner as gold solution except that platinum is substituted for the gold. During the action of the bath, free cyanid is formed that should be neutralized by the frequent addition of a little chlorid of platinum, preferably at the close of each operation. If a little visible amount of platinum should precipitate, this can be redissolved by the addition of a little soda phosphate.

195. Means of Maintaining Strength of Platinum Bath.—While with the bath just mentioned the platinic strength can be maintained by the occasional addition of a little fresh platinum chlorid, this method is not without objection. For small pieces, such as the dentist may usually wish plated, the chlorid bath will be entirely satisfactory, but for large pieces the replenishing of the solution during the process is objectionable. Attempts have been made to use an anode containing platinum in a very fine state of division, in the hope that this might be slightly soluble and thus maintain the platinic strength of the solution. Platinum-black was tried and the experiment proved the correctness of the supposition, but this did not prove to be a practical success. The laboratory experiment and the practical application were quite different conditions. In order to obtain the slightest solution of the platinum, the bath had to be of a strong acid reaction. This caused a loose, black, non-adherent precipitate that was of no value.

An alkaline platinate bath possesses some virtues over the acid bath just described. This is made up as follows:

Platinum hydrate	$\frac{1}{2}$ ounce.
Caustic potash	2 ounces.
Distilled water	1 quart.

Dissolve the potash in the water and then add the platinic hydrate slowly, keeping the solution in motion; a little heat will facilitate the solution.

Not more than 2 volts should be used in plating with this bath, for a heavier current will cause a non-coherent precipitate. The anode may be a sheet of platinum or a carbon plate not greatly exceeding the surface of the piece being plated. It is always a good plan to plate iron, zinc, and German silver objects with copper, prior to their receiving the platinum deposit. The strength of this bath can be maintained by the addition of platinum hydroxid. This may be in excess, as it will enter into the solution only when it is needed.

196. Silver-Plating.—Silver, like the two foregoing metals, is easily deposited from its solution, but not with such ease, however, as to become a troublesome feature in plating. Its behavior is so much like that of gold that if one were substituted for the other in some processes, the results would be equally satisfactory. There is one marked difference in the working of the two; whereas the gold deposit is very easily modified by the strength of the gold solution, deposits of silver do not appear to be affected by the strength of the solution from which they are deposited, except when extremes of either the density of the solution or the strength of the current are present.

197. The Silver Bath.—In operating with silver, the double cyanid of silver and potassium is most generally used. This is obtained by dissolving 1 part of cyanid of silver and 10 parts of cyanid of potassium in 100 parts of water. This may then be diluted to the desired strength, which may be from $\frac{1}{2}$ ounce to 5 ounces of silver to the gallon of water. The silver cyanid may be made by adding a solution of cyanid of potassium to a solution of silver nitrate, as long as a precipitate is formed. The supernatant liquid is then poured off and the precipitate washed.

198. Preparation of Surface for Silver-Plating.—All silver-plating solutions should contain an excess of cyanid of potassium, and this excess should vary according to the metal

to receive the plate. This may be largely in excess when depositing upon gold or platinum, but such metals as zinc, copper, and, in fact, all those metals that are generally attacked by the cyanid of potassium, require less excess of free cyanid. When the last-named metals are to be plated the work can be facilitated by "quickening" the surface by first washing it with a dilute solution of mercuric nitrate. As a matter of fact, if the surfaces of all metals are first quickened, then the cyanid strength of the solution can always be the same and the operator is relieved of any guesswork. This method should always be followed where one solution is used for plating different metals.

The quickening solution is made by dissolving an ounce of mercury in a 30-per-cent. solution of nitric acid and afterwards diluting with about a gallon of water. This is sometimes called the *mercury dip*. It is well to have some of this solution on hand, for it can often be used to advantage in plating with other metals than silver.

The function of free cyanid of potassium is to convert cyanid of silver into a double cyanid. In the plating process, silver cyanid is formed that is insoluble in the solution; free cyanid of potassium being present, it acts upon the silver cyanid and converts it into a double cyanid, which is readily soluble. The absence of free cyanid is shown by the anode turning a dark color, due to the formation of oxid of silver upon its surface; and an excess of free cyanid is shown by the anode assuming a very white and rough surface, giving it the appearance of a metal having undergone a violent chemical action.

199. Current-Strength in Silver-Plating.—The same rules are to be observed in the strength of current to be used in silver-plating that were laid down in gold-plating; a weak current, one scarcely stronger than is necessary to effect decomposition of the solution, will produce a fine, white, closely adherent coating, while a heavy current will cause a loose deposit of dark color, which will not take a good polish. The silver solution should not be exposed to a strong light when not in use, owing to the tendency of the silver salt to decompose.

200. Composition and Size of Anode.—In connecting the wires from the battery, the piece to be plated is swung from the negative wire and an anode of silver attached to the positive wire. The anode should be a sheet of perfectly pure silver that has been previously annealed. It should present a surface as large, at least, as the object to be plated. If the anode should present less surface than the object being plated, then instead of the plate furnishing sufficient silver to keep the solution at its proper degree of saturation, the solution itself gradually gives up its silver, until it becomes too weak for successful work. It is a good plan therefore to always use an anode that is a little larger than the object to be plated.

The current should always be flowing at the time of placing the piece in the bath. Unless this precaution is observed the free cyanid will act upon the object if it is a base metal, as is usually the case, dissolving it and contaminating the bath. A silver-plating bath containing copper, iron, or other impurities does not yield a pure, white, silver precipitate.

201. Silver-Plating Non-Metallic Objects.—Non-metallic objects may be silver-plated by making their surfaces electrically conductive by the use of graphite, as is done in electrotyping. Some years ago electrodeposited silver plates were tried by the profession. The claim of their advocates that such plates were accurately adapted to the model, was certainly correct, but these plates were found not to possess the necessary amount of stiffness for long and practical use, and this system of plate construction soon fell into disuse.

202. How to Polish Silver-Plated Surfaces.—Silver plate is finished much as one would polish a metal plate. As the article comes from the bath, if the plating has been properly done, it presents a white, frosted appearance. For some purposes this is a desirable finish itself. If, however, it is desired to give it a high polish, this can be done by the use of felt wheels, finishing with brushes and buffs, using prepared chalk and rouge. In some pieces, a beautiful effect can be obtained by burnishing the raised places and leaving the depressions in their original frosted condition.

COPPER-PLATING.

203. Use of Copper in Electroplating.—Copper, when used in electroplating, is of the greatest commercial value. It is not only used as a plating to give a copper finish itself, but is used as a foundation upon which other metals are to be plated. Some metals, platinum for instance, will not adhere to iron, zinc, or tin, with any degree of strength, and yet if these metals are first covered with a copper-plate, they will then receive the platinum with sufficient strength for commercial purposes. In this case the article is treated as if it were copper. Iron is best nickel-plated by first giving it a thin copper-plate.

Copper will deposit from some of its solutions by simple immersion. Iron, if dipped into a solution of copper sulfate, will receive a film of copper. It will be observed, however, that those solutions that precipitate metals most easily, as by the simple immersion of another metal in them, are not solutions most easily managed when used for electroplating. The very facility with which they give up their metal is an objection. While it is necessary that a solution should part with its metal when used for electroplating, it is possible to have an extreme, in its being too easily deposited. It is a noticeable fact that in some instances the more difficult a solution is to decompose, the better and more adherent will be the metallic deposit.

204. Acid Solution for Copper-Plating.—All the acid solutions of copper are easily decomposed and their deposits are, as a rule, but feebly adherent. The best results are obtained from alkaline solutions that only part with their metals under the influence of an electric current. An acid solution of copper will require a pressure of scarcely 1 volt to effect its decomposition, whereas an alkaline solution of the same will require a pressure of from 6 to 8 volts. Where it is desirable to deposit a very heavy copper-plate it is customary to first subject the piece to an alkaline bath, and when it has received a thin coating, to quickly transfer it to an acid bath. In this manner a thick and adherent plate is quickly obtained.

205. Alkaline Solutions for Copper-Plating.—The alkaline solution is made up as follows: Copper sulfate is dissolved in hot rain-water to about saturation. When this is cold, ammonia water is added till the solution assumes a blue color characteristic of ammonia sulfate. A precipitate will form during the first stage of the process, but it is afterwards dissolved. Next prepare a solution of cyanid of potassium, ½ pound to the quart of water, and add from this until the blue ammonia sulfate color disappears. A little of the cyanid should be added in excess. This solution can be used cold.

The anode of the copper-plating bath should be a sheet of pure copper. This can be obtained under the name of electrolytic copper, or an old copper from a Daniell cell may be used.

206. Method of Copper-Plating Small Articles. Owing to the ease with which copper solutions may be decomposed, small articles may be copper-plated by using a galvanic cell with a porous cup. Within the porous cup is placed a strip of zinc and a solution of sal ammoniac. The outer vessel contains a saturated solution of copper sulfate. The article to be plated is suspended from the zinc into the copper-sulfate solution, and the process goes on the same as though a galvanic current were derived from an independent cell.

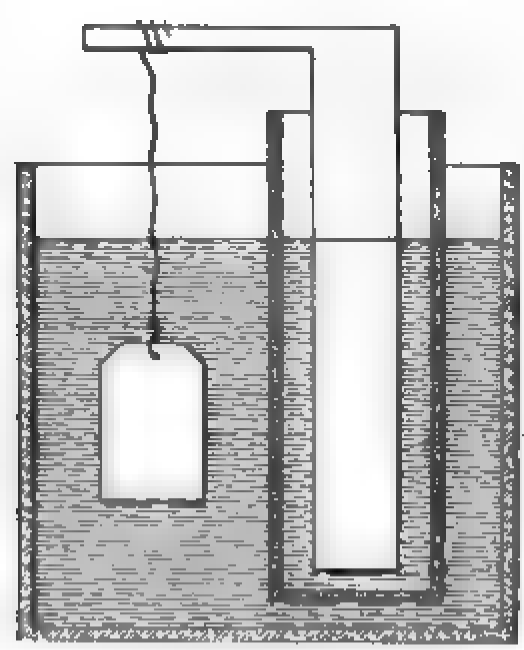

FIG. 63.

Single Cell for Copper-Plating.

COPPER AMALGAM.

207. Production of Copper Amalgam.—In 1888 and 1889 copper amalgam was advocated and used to some extent as a filling material. While this never came into general use, it, however, has virtues that make it a useful material in dental practice, not only for the treatment of children's teeth, but for

laboratory purposes. This material, being comparatively cheap, may be used for dies and counter-dies in crown- and bridge-work.

Copper amalgam was originally made by triturating precipitated copper in mercury in the presence of mercuric nitrate. This was a slow and tedious process, and when made in that manner was necessarily expensive. A paper was read in March, 1889, before the Mississippi Valley Dental Association, describing a method that made the process quite simple and the product very cheap, was simply the electroplating of mercury with copper. While the two metals have no affinity for each other, unless the surface of the copper is first washed with a solution of mercuric nitrate, and even then but feebly, if copper in a very fine state of division is presented to the mercury in a nascent condition, as it is in the electrolytic process, the two will unite and form a perfect amalgam.

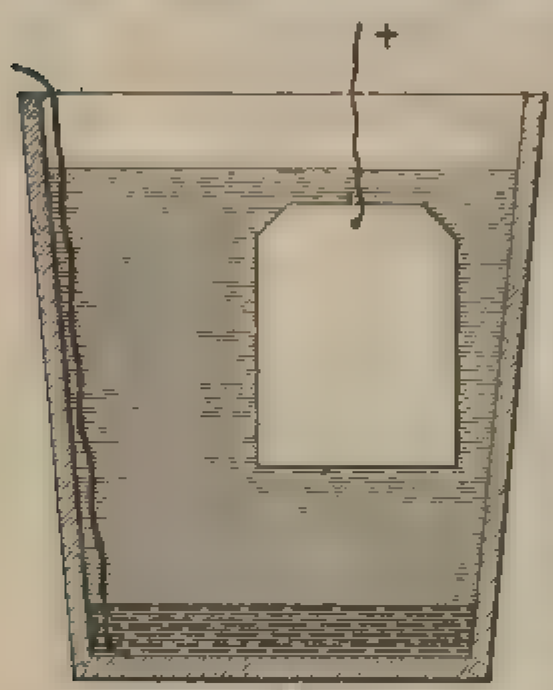

FIG. 64

Arrangement for Making Copper Amalgam

A glass tumbler may be used as the containing vessel, the bottom being covered with mercury and a wire led from this to the surface to which the electrical connection is to be made.

A plate of electrolytic copper is suspended above, which forms the anode. The vessel is filled with a solution of chemically pure copper sulfate, and crystals of the same added in excess, to keep up the strength of the solution.

When a weak current is pushed through the solution from the copper anode to the mercury, the solution of copper sulfate will be decomposed. Sulfur and oxygen, being electronegative, will be liberated in the form of SO_4, technically known as *sulfion*, at the positive electrode. Hydrogen and copper being electropositive, are liberated at the negative electrode. The

hydrogen escapes as a gas, and the copper, being in a nascent state, combines with the mercury, constituting the cathode in which it appears to assume a crystallin form.

When the mercury has become a thick mass, on account of the copper that it contains, the solution is poured off and the amalgam transferred to a mortar and triturated for a few minutes. The thick paste is quickly reduced to what again appears to be pure mercury. If, now, the mercury is taken up in thick chamois skin and manipulated just as the dentist does the amalgam preparatory to filling, the free mercury can be expressed, leaving a thick copper amalgam paste behind. This mass is again and again triturated and the mercury expressed until it becomes too stiff to manage, when it is put away to crystallize. In a day or two this mass will be found to be quite hard. It should then be gently heated in an iron spoon over a flame until mercury appears upon its surface in the form of minute beads.

It can then be crushed in a mortar and more mercury obtained from it in the usual manner. When the resulting mass of copper and mercury has been allowed to again crystallize, it is ready for use. It should, however, be put up in the form of little pellets to facilitate its working when used as a filling material.

208. Preparation of Copper Amalgam for Filling Material.—This material, if it does not contain too much mercury, is very hard when crystallized. It possesses almost a flint-like hardness, which, if the exact proportions of mercury and copper have been obtained, is such that it can be scarcely effected by a file, and yet after the application of a little heat, the pellet can be easily crushed and made into a plastic mass again.

When a mass of copper amalgam is allowed to harden it appears to undergo a crystallizing process, and when heat is applied the mercury seems to return to its fluid form, thus facilitating the breaking up of the pellet. In this manner the material can be worked over and over again, it only being necessary when the mass works too stiff, to add a globule of mercury to take the place of that lost by evaporation.

some effects, these metals require no finishing at all. If silver has been deposited in good condition, its natural frosted appearance is all that could be desired for some purposes. Nickel, however, is usually polished. The softer metals may be polished by the same methods that are used in the dental laboratory for dentures, or they may be burnished.

Often good effects can be produced by a combination of both buff polishing and burnishing. Nickel, however, requires different treatment for obtaining the high polish characteristic of the nickel finish. Nickel-plated articles should be immediately plunged into hot water when removed from the plating bath and then laid away to dry. When dry, the article is polished with a buff made of a large number of disks of calico mounted on a mandrel, with which may be used a little lime or prepared chalk.

CATAPHORESIS.

215. Discovery of Cataphoresis.—The term *cataphoresis*, from the Greek, meaning to carry along, is used in medicine and dentistry to designate a method of practice in which medicaments are introduced into the tissues by means of an electric current. As its phenomena become better understood the term appears to be correct, for there is little question but that medicinal agents under certain conditions can be bodily transferred by the aid of an electric current without suffering electrolytic decomposition, at least in part.

This property of the electric current was discovered early in the history of modern electricity. Davy had made known the phenomenon of electrolysis, and Oersted, Ampere, and Faraday were immortalizing their names by their discoveries in electromagnetism. About two years after Faraday's discovery of the electromagnetic property of an electric current in 1831, Fabré-Palaprat used a weak galvanic current to introduce iodin solutions into the tissues for medicinal treatment. While this method of medication did not receive universal attention, it however embodied all the principles of, and was the foundation of, modern cataphoresis.

216. Anesthesia by Cataphoresis.—Dr. W. B. Richardson, of London, in 1859, demonstrated a method of producing anesthesia by using a sponge saturated with chloroform or other anesthetics and placing upon this the positive pole of a battery current, the negative pole being in contact with another portion of the body. The method of Doctor Richardson differs from that of Fabré-Palaprat only in the medicinal agent used. The one is for local medicinal treatment and the other for producing anesthesia. The technic of both, as well as the results obtained, was practically the same. The Frenchman had success in his medicinal treatment, and in the same manner, about 25 years later, Doctor Richardson produced local anesthesia.

217. Cataphoric Use of Cocain.—During the next 30 years this subject was studied by Peterson, in this country, Lawrence and Harris, in England, and may others. In 1888, Dr. D. F. McGraw contributed two articles before the Minnesota state and local dental societies upon the cataphoric use of cocain for sensitive dentin. A third paper by Doctor McGraw was read upon the same subject the following year at the twenty-fifth anniversary of the Chicago Dental Society by Dr. Thomas E. Weeks, Doctor McGraw not being present. This method had been in practical use to a limited extent by Doctor McGraw and his friends, for Doctor Weeks at the same meeting in a paper of his own upon the treatment of sensitive dentin, speaks of having painlessly removed pulps of ten teeth after the McGraw method.

Doctor McGraw used a 6-per-cent. solution of cocain in alcohol, applying the positive pole to the pledget of cotton containing the medicament. He used four cells of battery, which would have given him about 6 volts' pressure. The length of time in making an application was from 3 to 9 minutes. In this manner, in not the least particular different from the practical use of cataphoresis of to-day, Doctor McGraw was enabled to anesthetize the dentin of the tooth.

218. Doctor McGraw's Theory of Cataphoresis. Doctor McGraw's theory of the mode of action was as follows: "The galvanic current acts as a vehicle for conducting the

medicinal agents; the cocain current anesthetizes the odontoblastic cells and the pulp; the styptic properties of the alcohol act upon the dentinal fibrils, they being of an albuminous nature, causing contraction and increased density and firmness." The theory of the action of cataphoresis is still unsettled, and it may be said that the one promulgated by Doctor McGraw is possibly as nearly correct as any that have been advanced in later days.

219. Dr. A. G. Westlake contributed an article on "Electricity; Its Application in Dental Practice," in 1892, in which he touches upon the use of cocain electrically applied for the treatment of sensitive dentin.

But little attention, however, was paid this subject by dentists until it was brought to their attention in 1895 and 1896 by Dr. W. J. Morton, of New York, and Dr. Henry W. Gillet, of Newport, Rhode Island. Doctor Morton presented two papers upon the subject, one in June, 1895, upon "Cataphoresis and Solutions of H_2O_2 for Bleaching Teeth," and one in January, 1896, upon "Guaiacol-Cocain Cataphoresis and Local Anesthesia." Both of these agents were to be cataphorically applied. Doctor Gillett, in 1895, presented a paper before the New Jersey Dental Society, and a week later one before the American Dental Association upon "Cataphoresis for Obtunding Sensitive Dentin." Here, for the first time, the dental profession awoke to the possibilities of cataphoresis for the application of medicinal agents, its possibilities in the treatment of sensitive dentin, for the painless removal of live pulps, in fact as a panacea for all that was painful in dentistry.

220. Volt Controller.—While the experimenters, up to this time, had not complained of the difficulties attending the process from an electrical point of view, it seemed that, for the use of the current on sensitive dentin, provision must be made for a very gradual increase in its strength, not by jumps of a cell at a time, but by the gradual increase of the fraction of a volt. In fact, it was soon learned that the tooth was so sensitive to electricity applied in this manner that it could detect an increase in the pressure of less than $\frac{1}{10}$ volt. For the purpose

of meeting this problem, Mr. G. M. Wheeler devised what he termed a fractional volt selector This was simply a shunt rheostat so constructed with a large number of steps that the increase from step to step would not produce a shock that would be painful to the patient. This is shown in Fig. 65.

FIG 65
Wheeler "Fractional Volt Selector."

The introduction of this appliance, supported by the wonderful claims for cataphoresis made by Doctors Morton and Gillett, marked the beginning of the cataphoric wave in dentistry.

THEORIES OF CATAPHORESIS.

221. Osmotic and Electrolytic Theories of Cataphoresis. From the very beginning of the practical application of electricity for cataphoric purposes, a variety of theories have been set forth that attempted to explain the exact nature of the phenomenon And, even at this day, there appears to

be no unanimity of theory as to the precise method of action, in spite of the fact that it has been shown that medicinal agents can be diffused into a porous and electrically conducting substance, in a state that appears, both in its chemical respect and in its therapeutic effect upon animal tissues, to be unchanged.

222. While the phenomena of electrolysis are familiar to most people, and the laws governing the changes produced thereby are well understood, there does not seem to be an equally clear conception of osmose, or rather electric osmose, as the electrical process is called. In electrolysis, the decomposition of compound substances, the reformation of new compounds according to their electrical affinities, and the transfer of elements, follow certain laws that are well established. The splitting up of a compound into groups of the same electrical polarity, the formation of ions, and their travel toward the pole of opposite polarity, is a well-known law of electrolysis.

In osmose, without the aid of electricity, there is a diffusion of liquids through a membrane or porous partition that goes on as the result of molecular attraction. This is purely a physical force due to the difference in affinities between the two solutions. A vessel with a membranous partition, having a solution of sugar on one side and an equal height of pure water on the other, will undergo a change of level due to the passage of a portion of the pure water into the sugar-water compartment. This is simple osmose.

If, now, we take a like vessel and fill each compartment to an equal level with the same fluid, no change takes place, ordinarily. If, however, a current of electricity is passed through the two compartments, a portion of the liquid will be carried through the membrane in the direction in which the current is flowing in a manner similar to the osmose of different liquids. This is electric osmose or cataphoresis.

In electrolysis there is a splitting up of the molecule according to affinities. The electropositive element or elements forming an ion travel toward the negative pole while the electronegative travel in the opposite direction. In simple cataphoresis there is a bodily transportation of the solution without

decomposition. In dentin cataphoresis, where the conditions are not as favorable as in the case of the vessel with a simple membranous septum, both processes may be going on at the same time. That is, there may be an electrolytic decomposition of the cocain in the cavity of the tooth and at the same time a conveyance of some of the cocain solution into dentinal canaliculi.

223. Doctor Price's Theory.—Doctor Price is of the opinion that the underlying force in cataphoresis is not as just stated, but that the whole process is carried on by the same laws that govern simple electrolysis. He believes that the cocain is first split into ions, and that the electronegative ion is the part that enters the dentin and that produces the anesthetic effect. If it can be shown that the electronegative ion of the cocain solution is an anesthetic, then the theory of Doctor Price becomes most plausible, and instead of this process being a cataphoric action, it is electrolytic, pure and simple.

224. Electrolysis During the Process of Cataphoresis.—There is no question but that electrolysis is going on to a large extent; perhaps this is the greater part of the action in the cavity, as is shown by the active liberation of gas and the rapid change to a strong acid reaction, as has been shown by Prof. J. S. Cassidy. But even in excess of all this we believe that, following the laws of electric osmose, a portion of the cocain is carried into the dentin without having suffered decomposition. The laws governing electrolysis are fixed, and, in like manner, are those governing osmose. Electric osmose may be carried on through a simple membrane with little loss by electrolytic decomposition, but in semiporous conductors and with the use of certain agents more or less electrolytic action will also be going on at the same time.

In summing up the two theories, that is of simple electrolysis in which the ion carried into the dentin is the anesthetic, as promulgated by Doctor Price, and of the carrying in of the cocain bodily, we must not overlook the fact that both processes are probably going on at the same time; and until it is clearly

demonstrated that the electronegative ion of the cocain solution is capable of producing the anesthetic effect, which is characteristic of the undivided cocain solution, we may maintain the belief that the anesthetic effect, after all, is due to electric osmose or cataphoresis, as it has been termed.

ELECTRICAL CONSIDERATIONS OF CATAPHORESIS.

225. **The electrical considerations that enter into the successful application of cataphoresis for the relief of sensitive dentin are somewhat complex, and it may be said that there is no process in dental practice in which final success depends so much on the precise carrying out of every little detail as in cataphoresis. The slipping of a clamp, the leakage of the rubber, the presence of an unsuspected filling, a broken connection, and many other things, which, of themselves, may be so slight as to escape notice unless the operator realises the full importance of every detail, will cause a failure in the end.**

SOURCES OF CURRENT.

226. Since in cataphoresis there must be an actual conveyance of the medicinal agent, the current must flow in one direction. It may be continuous, pulsating, or interrupted, but so long as it flows in one direction when in motion, the result will be the same, and a suitable agent will be carried with it. It has long been observed, however, that the more uniformly the pressure is maintained on a continuous current, or the more gradually it is raised, the less it is felt in its various applications in electrotherapeutics, and in proportion as the pressure varies, while it may still be continuous, it will be painful to the patient. It may therefore be stated that under steady pressure a weak continuous current is not painful, but becomes so when it pulsates. It becomes more so when it is interrupted, and still more so when it is reversed in direction. It is for this reason that the interrupted current is used in shocking machines and that the alternating current is so deadly. Doctor Morton and others prefer the galvanic current partly for the smooth voltage that is characteristic of this current, and the small amount of

pain accompanying its applications. On the other hand, there are those that claim that the Edison current furnishes a practically uniform voltage. Theoretically, the galvanic current gives the more uniform pressure, but those that use it seem to overlook the fact that they annul this virtue of battery power every time they touch the rheostat for increasing the current, as is customary in its application.

If we are endeavoring to use a current from a source that will give the least fluctuation of pressure, the thermopile should be used instead of either; for here we have a current not dependent on a chemical action that is not uniform at all times during the action of galvanic batteries, nor is it dependent on the fine division of the segments of the commutator of the dynamo-generated current. The current derived from the thermopile is dependent on the difference in temperature that exists at the opposite ends of the couplets. In the practical operation of this instrument heat is applied upon the inner ends of the couplets, and as their temperature rises, electromotive force is felt at the terminals. This increases gradually to the limit of the appliance, where it steadily remains. Owing to the large mass of metal and its heat-retaining property, the current from the thermopile will be the most uniform in pressure that can be obtained from any source. But, as before stated, this virtue is lost when a rheostat is used for gradually bringing up the pressure, as is the method in the practical application of cataphoresis.

227. The Edison Current.—The Edison current is ordinarily supplied at 110 volts pressure. This does not vary to any great extent at any time. When it does it is usually so slow that the change will not be felt by the patient. In nearly all cities the pressure drops at about 5 o'clock, owing to the large amount of current consumed at that time in the lighting of the houses and stores. This, however, is a gradual drop and it may take an hour to show a change of 2 volts. It should not therefore be considered a serious objection to the commercial current.

There is another condition, however, that entirely forbids the

use of the commercial current for cataphoric purposes Many dental offices in large cities are in office buildings that operate their own plants This current is used for the light and power of the building. In many cases the elevators are operated from the same plant. In these instances the feed-supply has not the reserve to be unaffected by the sudden demand for current necessary to operate the large elevator motors, and while such a current is practically steady for power and lighting purposes, it is unfit for cataphoresis. The pressure will fluctuate to such an extent as to be painfully felt by the patient. In a few instances of city supply, the dentist may be obtaining his current from the same line that supplies a large motor in the neighborhood. In this instance, also, the commercial current is unfit for cataphoresis.

Ordinarily, however, the commercial 110-volt constant current can be satisfactorily used for cataphoric purposes, but with certain precautions. When the current used for cataphoresis is what is known as a current in shunt with the main, as all such currents should be, the variation in voltage at the poles is in the same proportion as the voltage of the cataphoric current is to the 110 voltage of the main current. For instance, if the voltage of the Edison current is 110, and the voltage of the cataphoric current averages 10 during the administration, it would be necessary for the Edison current to vary 11 volts to produce a variation of 1 volt in the shunt; or, in other words, a variation of 5 volts, for instance, an unusually large variation in the main current, will produce a variation of but ½ volt at the cataphoric poles. Such a variation in the main of a commercial current is very unusual, and should it occur, it is scarcely more than takes place when the dentist operates the rheostat for raising the voltage. The cataphoric current can sometimes be increased from 1 to 5 volts without being painful to the paitient. Altogether, the objection to the commercial current on the ground of its unsteady pressure does not appear to be as strong as is claimed, and especially if the cataphoric current is a shunt to the main. In some appliances, as shown in Figs. 65 and 66, the cataphoric current is made a third shunt to the main, which gives a current of unusual smoothness.

228. Dangers to be Avoided When Using the Edison Current.—There is a more important objection to the commercial current than that of its unsteady pressure, and that is the danger of a sudden shock, due either to grounding or to crossing of the wires. In many offices, a fountain cuspidor is attached to the dental chair. While there may be no metallic connection between the chair and the water-pipes, the column of water in the rubber supply-tube furnishes a path of sufficient carrying capacity to supply all the conditions for a good ground. This may not be sufficient to operate a motor or a lamp, but it is ample for cataphoric mischief. It has been repeatedly tested and found that, under certain conditions and arrangements of connections, it is possible to have nearly the full-current pressure operative. It is an easy matter for the patient at the time of an application to touch the metal work of the chair, and should the connections be carelessly made, a severe shock will ensue.

The second source of danger is from the supply-current itself. In the three-wire system it is not an uncommon occurrence to accidentally cross or connect the two outer wires together. In so doing the voltage of the cataphoric current is doubled and a patient under administration receives a severe shock. The current to the patient is just twice its original voltage, and while the shock from this increased voltage is not dangerous, it is one that should never happen to either patient or operator.

Much has been said of the dangers that might follow the accidental crossing of the power and arc-light wires with the 110-volt conductors. There is very little danger from this source unless there should be a ground through the patient at the same moment. The high pressure of the other circuit will dissipate itself immediately in the ample outlets of the lower pressure currents. It would be much like trying to raise the pressure of the water in the large mains by injecting into one of the pipes a fine stream under high pressure. The many outlets that are constantly open on the mains prevent even the slightest rise in pressure from the additional fine stream of water under high pressure. It may be slightly felt in the immediate neighborhood, but the rapid dissipation through the many outlets will prevent any general effect.

If the operator will bear these possibilities in mind and insulate his fountain cuspidor from the metal work of the chair by means of fiber bushings, he may use the 110-volt current for cataphoresis with reasonable safety. His current-supply should come directly from the mains, and there should not be an intermittent use of large quantities of current in the immediate neighborhood. Nor should he himself be cutting current in or out for the operation of other electrical appliances in his offices; for the supply-wires to his office, while heavy enough to carry all the current necessary, usually have sufficient resistance to cause noticeable variation if other appliances are used at the same time.

229. The Battery as a Source of Current.—A much safer method, although not as convenient, is the use of a battery as a source of current. Having gone over the entire ground both as an operator and as an inventor of cataphoric appliances, we recommend a battery consisting of about a dozen Leclanché cells, such as are to be found upon the market for operating bells and telephones. Dry cells may be used with some satisfaction, but their short life is an objection, which, it seems, is scarcely balanced by their natural cleanliness. The storage-battery is still another source, but unless the operator has other uses for it the necessary attention scarcely justifies the use of this battery for this purpose. The Leclanché cell first referred to is an open-circuit cell and is not wasting itself when not in use. Its period of action is usually long enough to supply a continuous current for cataphoresis for a sufficient length of time. In practice, cataphoric applications are not usually so frequent or so numerous but that the battery has had time to recuperate between intervals.

BASIC ELEMENTS OF A SUCCESSFUL OPERATION.

230. Conductivity of Enamel.—The tooth, the enamel, the arrangement of the canaliculi of the dentin, the relation of the pulp, and the position of the negative electrode are considerations, the importance of which cannot be over-estimated. These are the foundation of a successful cataphoric operation.

The enamel consists of 97 per cent. of lime salts, which is a non-conductor of electricity, and the remaining 3 per cent. of animal matter is such a small amount that it offers so much resistance as to be practically a non-conductor. This fact that a sound tooth is covered by a non-conductor of electricity has an important bearing upon cataphoric operations, and it may have a physiological significance as well.

231. Conductivity of Dentin.—On the other hand, the dentin is made up of about one-third animal matter, which contains water, making it a good conductor of electricity. The matrix of the dentin is almost a solid lime structure, and, like the enamel, is a non-conductor. But within the tubuli, which are radially arranged centering at the pulp canal, are contained the dentinal fibrils that are made up almost entirely of water. It is these fibrils that we wish to obtund, and, fortunately, the large percentage of water makes them good conductors of electricity. When current is applied it follows these canals to the pulp. Herein lies the importance of first enlarging the cavity at its opening as much as possible before applying the current, for the fibrils anastomose so little that the area of anesthesia will be confined almost entirely to those tubuli whose mouths open into the cavity. It is only in long applications, and where the cataphoric effect reaches the pulp, that the fibrils supplied to other portions of the crown will become anesthetized.

232. Current Used.—The quantity of current that can be used in an operation, the length of time and the pain limit being equal, depends entirely on the area of exposed dentin. In the first days of dentin cataphoresis, widely different reports found their way into print as to the quantity of current used. In one case the operator could scarcely reach more than $\frac{1}{10}$ milliampere, while in another he reached as high as $\frac{1}{2}$ milliampere, and, in a few cases, due to the leakage of the rubber, he might register 50 milliamperes. The cause for all this was to be found in the area of exposed dentin, or, as in the last case, an accident. A small exposure of dentin is like a fine wire; it offers more resistance than a large cavity or a thick wire. In the practice of cataphoresis we must consider the path from the

positive pole in the cavity to the negative pole at the sponge to be like a funnel with a small end equal to the area of exposed dentin, and the large end the area of sponge upon the face or hand. No more water can flow through the funnel than can pass through the smaller end, and in like manner no more current can flow than can pass through the exposed tubuli; and at the same voltage the current increases in proportion to the size of the cavity Dentin that has been denuded of enamel by attrition offers greater resistance than freshly exposed dentin, by reason of the filling in of the tubuli.

233. Position of the Negative Electrode.—The position of the negative electrode has much to do with the application of the current The shorter the distance that this is placed from the tooth under operation, the less voltage will be required to force the current through, and the less will be the variations due to the alleged pulsations of the Edison current. It is always expedient to operate at as low a voltage as possible After experiment, we have found that it usually requires about twice the voltage when the sponge is held in the hand as when held upon the cheek. It is therefore recommended that the negative pole be placed upon the cheek and held in place by the same appliance that ordinarily holds the rubber dam in place By so doing, the pressure need seldom exceed 15 volts, and the operator is relieved of the care of holding the negative electrode.

USE OF RHEOSTAT AND AMMETER.

234. The Rheostat.—When cataphoresis was first presented to the profession in a practical form by Doctors Morton and Gillett, the instrument shown in Fig 65 was the one most suitable. As a matter of fact, it was designed for the special purpose. This instrument, which is called a *rheostat*, was a secret in its construction at the time, and a method of obtaining a current from the 110 volt circuit that could be easily and accurately controlled, was devised. Such a current must start from zero and increase by very small steps, at least 10 to the volt, to about 20 volts.

The most popular rheostat and cataphoric outfit upon the market is the one made by the S. S. White Company, which is

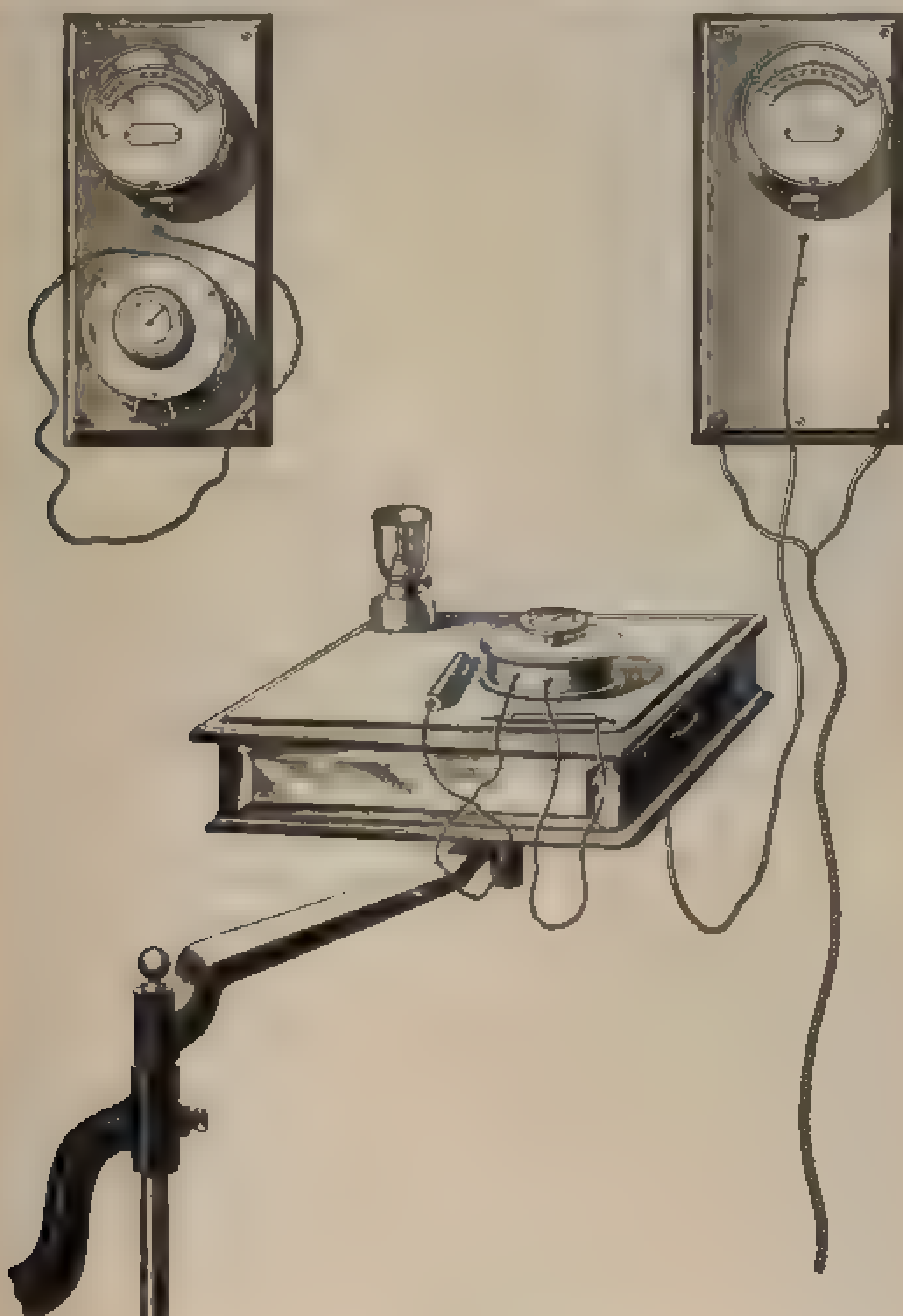

FIG. 66.
S. S. White Cataphoric Appliance

shown in Fig. 66. This instrument is designed in the form of a wall-bracket, from which the rheostat is removable. The ammeter, a necessary adjunct, is seen above.

When making a cataphoric operation, the rheostat is placed upon the operating-table, so as to be within easy reach of the operator. The rheostat of this appliance is a shunt instrument and is of the graphite variety. This form of rheostat is especially suitable for cataphoric purposes, for the reason that there will be no perceptible steps when the current is increased. The rheostat is, moreover, so designed that in turning the regulating wheel an index finger also travels over a scale that is divided into one hundred equal parts. The scale may also be made to read in volts, thus answering a twofold purpose.

The Ritter Dental Company also supplies a cataphoric appliance for the market. This, as shown in Fig. 67, is somewhat larger than the one just described. It is a shunt rheostat in principle and the steps are imperceptible to the patient. One of the thumbscrews is for turning the current on very slowly, and the other for a more rapid movement. While the current cannot be withdrawn from the patient suddenly, the voltage can be quite rapidly reduced, more so than can be done by the thumbscrew that turns on the current. A second thumbscrew is therefore provided for turning off the current.

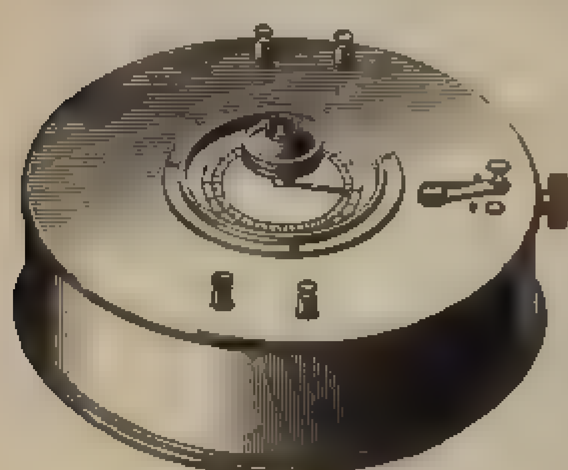

Fig. 67

Ritter Cataphoric Rheostat.

235. The Ammeter.—Besides the instruments for supplying the current for cataphoresis, there are several adjuncts necessary for a successful administration. The most important of all is an ammeter. This may be as simple as an ordinary compass placed upon a spool of fine wire, which is in series with the patient. A large thread spool may be wound full of No. 34 silk-insulated wire and this fixed upon its side to a wooden base, the two ends of the wire having been brought out to binding-posts. A jeweled compass 2 inches in diameter is then mounted upon the spool Such an appliance is

ordinarily known as a galvanometer, but when wound in more complicated ways and mounted in commercial form, it is called an *ammeter*, as shown in Fig. 68.

This appliance is one of the standard instruments for electrical measurements. While it differs considerably from the form of galvanometer previously described, the points of difference are the essentials that go to make up a perfect instrument. This instrument is not measurably affected by the earth's magnetism like the ordinary galvanometer, nor is it affected to any extent by the near presence of iron or any electrical instruments that may be in operation. Instead of there being a permanent magnetic needle that swings under the influence of an electromagnet underneath, the moving member of the Weston ammeter is an electromagnet. This does not become magnetic until current passes through it. The S. S. White

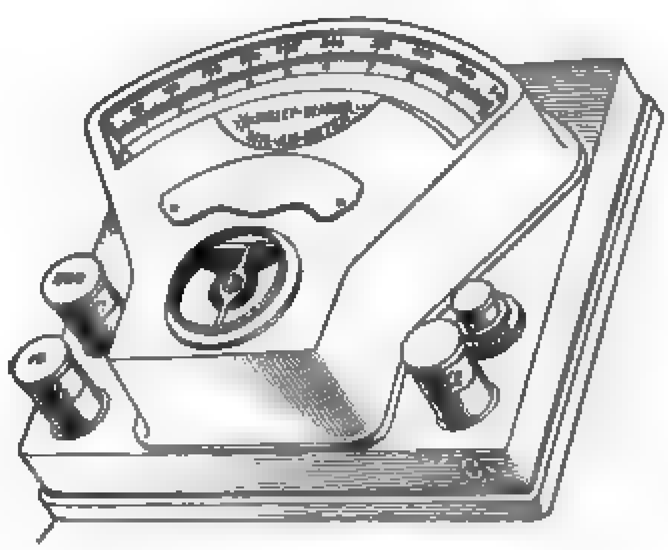

FIG. 68.
Weston Mill-Ammeter.

appliance, in Fig. 66, is fitted out with a special form of Weston ammeter. The scale is in thousandths of an ampere, and each thousandth may be read to the one-hundredth part, so delicate is the instrument. This instrument is, moreover, what is known as a "dead beat," meaning that the index finger goes at once to the proper reading without the wavering so characteristic of most galvanometers.

236. The purpose of the ammeter is just the same in a cataphoric administration that the scales and graduates are in the dosage of medicine. It is by this means that the operator tells just how much current is passing and with the element of time he computes the dosage. The two factors, the ampere-strength of current and the time consumed, determine the depth and quantity of cataphoric infusion. After a little

experience the operator can mentally estimate the required time simply by watching the reading of the ammeter. Of course there are conditions that determine the strength of current that should flow in each case. The size of the cavity is the most important feature that will call for careful judgment on the part of the operator. A large cavity will permit more current to pass than a small one, and only experience and close attention to this fact will enable the dentist to use the exact length of time to infuse to the desired depth. Some cavities, and even different cavities for the same patient, will allow of a larger dosage than others.

237. The ammeter is also valuable for another purpose. It will tell whether there is any leakage of current at the neck of the tooth. While the adjusting of the rubber is always a necessary step, it is still more important to see that it does not leak. If the rubber should leak, it offers a path for the current of so little resistance, comparatively, that the current will nearly all flow through the leak. In the first days of cataphoresis several cases of loss of gum-tissue were reported, due to destructive electrolysis from this cause. Such an accident is now inexcusable, for by the use of an ammeter the dentist can quickly tell whether or not there is a leakage of current around the tooth. In the average dental case, more than $\frac{4}{10}$ milliampere can seldom be used without pain. If the ammeter shows more than this, it indicates a leakage. In some cases of leakage the ammeter may go as high as 25 milliamperes, and yet, on inspection, a leak cannot be found; but it is there and another adjustment of the rubber should be made.

238. The amperage that one should expect in each case depends on the the area of exposed dentin, the condition of the cavity, the voltage of the current, and the position of the negative electrode. The area of exposed dentin and its relation to the dosage has already been touched upon. The condition of the application in the tooth cavity, however, has not been. This has much to do with the strength of the current flowing. A large proportion of cocain solution is lost by electrolysis. It takes but a few moments to entirely decompose a drop of the

solution under the conditions of dentin cataphoresis. For this reason, unless the cavity is kept flooded with fresh solution, the cotton will quickly become dry, and the resistance will be double what it would be if the cotton were kept saturated. The effect of this upon the meter reading will be seen by the index finger dropping back to near the zero-mark. Nor is this the only reason why the cavity should be kept flooded with the cocain; the shock to the patient caused by adding fresh solution to the cotton is severe and should never occur. Much more time than is necessary is often consumed when the cotton is allowed to become dry.

239. Difference in Susceptibility of Patients.—It will be noticed that there is quite a difference in patients in point of their susceptibility to the electric current. This is so marked that it is a feature meriting consideration. The operator should not be misled by the supposition that where very little current could be used without producing pain the penetration had been deeper. The idiosyncrasy of the patient will oftentimes not allow of a high voltage, and a longer time must be given at a low voltage, and, consequently, low amperage, to produce the desired result. Again, even in patients not especially sensitive to an electric current, there will be a marked difference in the voltage that may be used in different cases. A cavity that has been slow of progress, or an abrasion in an aged person, will allow of a much higher voltage than a fresh and rapidly forming cavity in a younger person. While the wide range of conditions may be present in cataphoric operations, and it would seem that a voltmeter is not of much value as the pain limit alone determines the pressure that is allowable in

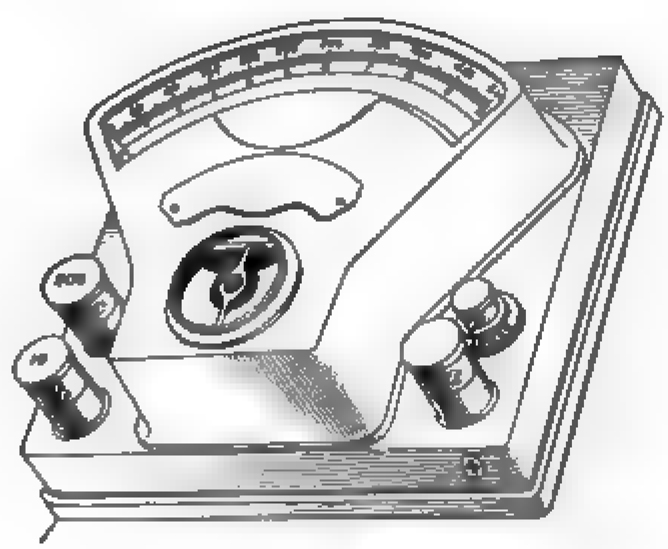

FIG. 69.
Weston Voltmeter.

each case, one may still be used to advantage. It is an aid in calculating the length of time that will be necessary, a signal in case of grounded wires, a guide as to care necessary in maintaining a saturated solution, and an index in turning off the current.

240. Resistance.—The position of the negative electrode has much to do with the meter reading. If this is placed in the palm of the hand a much higher voltage will be required than when placed upon the cheek. This is due to the resistance of the dry epithelium upon the hand and of the longer path through which the current must travel. Doctor Price has estimated that the average resistance from the tooth to the hand is about 9,000 ohms, whereas the resistance from the cheek to the tooth is 3,000 ohms. The resistance offered by the tooth depends, as previously stated, on the area of exposed dentin, the depth of the cavity, and the condition of the dentin. This ranges all the way from 15,000 to 150,000 ohms, the average resistance being about 25,000 ohms.

MAKING AND APPLYING THE ELECTRODES.

241. The Positive Electrode.—The positive electrode used in dentin cataphoresis should be of platinum, the object of using this metal for the purpose being that platinum is not affected by the electric current. All the baser metals and some of the noble metals will be dissolved by the currents if used for this purpose. In certain cataphoric treatments, where it is desirable to apply a nascent metal, or the salt of a metal, the positive electrode is made of that metal with the expectation that it will be dissolved. Zinc and copper are often used as soluble electrodes for this purpose. In dentin cataphoresis it is not desirable to infiltrate the dentinal fibrils with anything but the medicament, and platinum is therefore used in this instance. In the first days of cataphoresis the positive electrode consisted of a platinum point in a rubber-covered handle. It was intended that this be held by either the assistant or by the operator himself. The S. S. White Company supplied an

unique instrument for this purpose, shown in Fig. 70. The handle is of rubber and made hollow, but with a metallic connection running throughout its length. A piston plays upon the inside by which the electrode can also be used as a syringe for supplying the cocain solution.

It soon becomes apparent to the operator, however, that the positive electrode should be fixed in the cavity whenever possible. In cavities very difficult of access the hand electrode is the only instrument that can be used. In accessible cavities, however, a rubber dam clamp may be attached by means of a little hard-rubber clip, which at the same time insulates the wire from the clamp. A similar appliance is shown in Fig. 71.

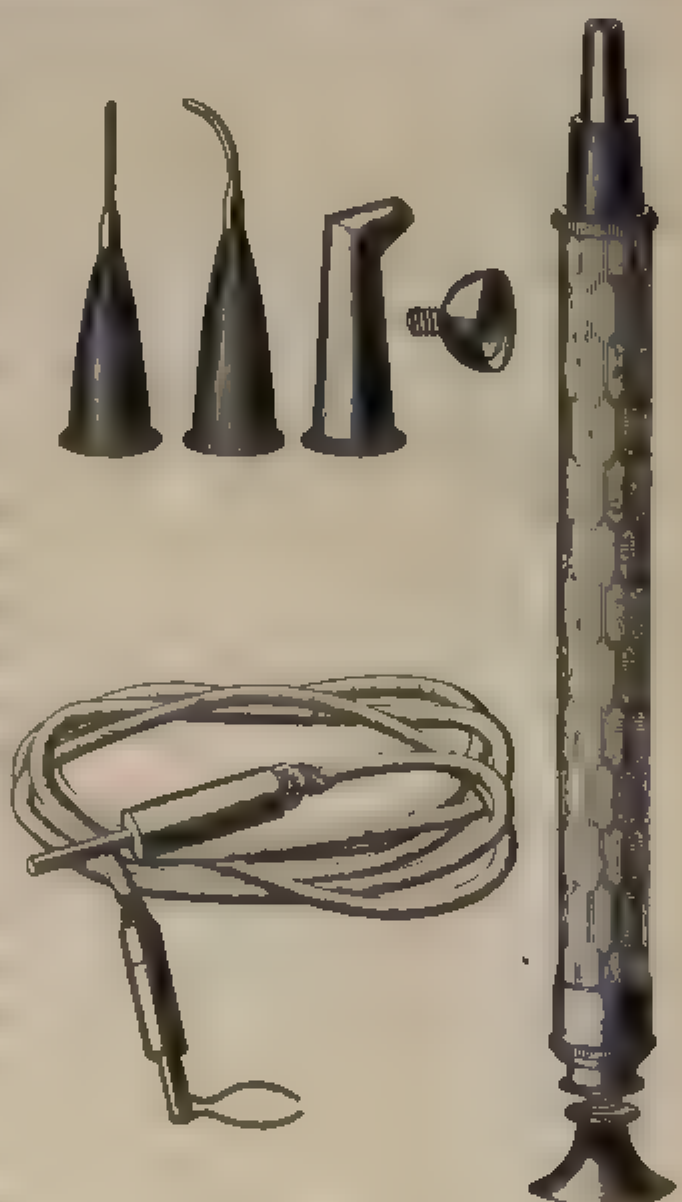

FIG. 70
S. S. White Positive Electrode.

242. A much better and quicker method, however, is that first suggested by Dr. Weston A. Price. He attaches a hair-like platinum wire to the positive terminal, which is very light and flexible. A pellet of cotton, the size of a cavity is entwined with a fine platinum wire and the whole packed in the cavity. This will usually be retained by the cavity, and especially if a light tinsel cord is used as the conductor to the same. This cord, although very light and flexible, has ample carrying capacity for cataphoresis.

When the positive electrode is fixed in the cavity in the above manner, it not only relieves the operator of this tiring detail but allows him freedom to attend to others. Nor can any operator hold an electrode by hand as comfortably to the patient as one mechanically fixed in the cavity. The hand electrode must be stiff at the point to enable the operator to use the slight pressure that is necessary. It is impossible, even with the closest attention, to hold the instrument in the cavity with unvarying pressure throughout the administration. If the operator bears too hard and the knob-like point is heavy enough to resist the pressure without bending, the cocain is squeezed out of the cotton directly under the knob, and the operation is a failure for the unaccountable reason that cocain cannot penetrate the tubuli under the instrument point, and the pain effects will be too severe for a complete and successful administration. During the cataphoric application of cocain for sensitive dentin, the rapid loss of the solution by electrolysis, which is going on in the cavity, produces a constantly changing resistance, and this, with an unsteady electrode, is often sufficient to cause a failure. It is therefore important, as one of the first steps, to secure the anode in the cavity in such a manner that it will be steadily held either by its own pressure or by some mechanical appliance.

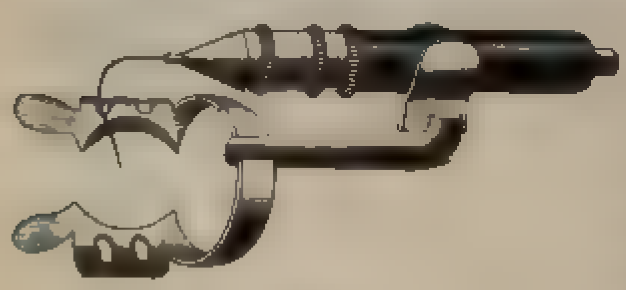

FIG. 71

McIntosh Electrode

243. The Negative Electrode.—The negative electrode, which is to be used upon another part of the body, should be made of a pad of white blotting-paper saturated in a solution of common salt, a new one for each patient. Some appliances are fitted with a hand electrode to be held by the patient. This is objectionable for three reasons: first, the negative pole, as has been shown, should be placed as near the positive as possible; second, the thick epithelium of the hand, especially if dry, offers very high electrical resistance; and third, the

constantly varying grip of the patient produces slight shocks. If there should be sudden pain at the cavity, the patient most naturally increases the grip upon the hand electrode, which further increases the shock.

The blotting-paper electrodes should be about the size of a silver dollar. They should be cut from new blotting-paper in quantities, soaked in a nearly saturated solution of common salt, and then put away to dry. The appliance for holding the pad should be a vulcanite disk, with a recess deep enough to contain a thin sheet of metal and the blotting-paper, which is placed on top of the same. At the time of operating, the pad is placed in the recess where it will remain after being moistened with water from the syringe. The disk, with the blotting-paper next to the flesh, should then be slipped under the same appliance that ordinarily holds the rubber dam in place upon the cheek, where it will remain throughout the operation. By this arrangement we have cleanliness, the shortest distance between the electrodes, and safety from shocks.

MODE OF PROCEDURE.

244. Insulation.—The first and most necessary step in cataphoresis is a thorough insulation of the tooth by means of the rubber dam. The rubber may leak during the making of a filling, and the operation may not be materially interfered with, but in all cataphoric operations upon dentin absolute insulation of the tooth, and neighboring teeth if included, must be secured. In the adjustment of the rubber for this purpose, it is not well to include too many teeth, because of the difficulties of perfect insulation, and often of the presence of fillings in them. The rubber should not be pressed below the enamel, except in the region of those cavities that extend to the gum and that are the ones to be operated upon. If a rubber-dam clamp is used, it must be seen that it does not crowd down below the enamel, or, if it should, that the cocain solution does not touch it. If the current should find a path through the clamp it will produce a very unpleasant condition of things. The current will pass from the clamp into the dentin without

producing anesthesia, and the operation will, on that account, be a failure.

Many cataphoric operations have failed, in a painless point of view, by reason of some hidden metal filling or by some unobserved leakage of the solution toward a filling that may be in plain sight. For this reason, all metal fillings that are likely to be reached by the cocain solution should be first painted with gutta-percha, which will act as an electrical insulator.

245. Removal of the Enamel.—The second step is the thorough removal of all the enamel that is to be taken away in the preparation of the cavity. This usually causes but little if any pain, and is a necessary step, inasmuch as the cocain does not penetrate to any extent in a lateral direction. Many operators failed to succeed with cataphoresis by overlooking this fact. It has been shown that the current enters and follows only those tubuli whose mouths open into the cavity; hence it would be unreasonable to expect no pain when operating on the margins of a cavity that had not been denuded of enamel, unless the administration has been kept up long enough to reach the pulp and the lateral fibrils have lost their sensation from that source. It may be that, in many cases, the thorough removal of enamel cannot be made before making the cataphoric application, but if it is not, the usual sensitiveness will be found at these margins except in those cases where the cocain reaches the pulp.

246. A combination of electrozone and cocain was at one time recommended under the impression that the electrozone would aid as a carrier. Experience, however, soon demonstrated that after all, cocain was the active agent and that it is a good conductor of electricity without the addition of an agent for that purpose. It quickly manifests an acid reaction, indicating that it has become a good conductor. The question has been raised whether or not any agent, to be cataphorically transfused, should itself be a conductor. The vehicle in which it is suspended may be, and in this manner the conditions are fulfilled, the vehicle conducting the current and the anesthetic

being carried with the movement of the current. In most cases a saturated solution of cocain in water is the most satisfactory agent or combination of agents. The aim is to convey cocain into the tubuli, and in order to do this, cocain must be present. Inasmuch as there is no danger of producing cocain poisoning by an overdose when it is administered in this manner, a saturated solution is always used.

247. Test for Polarity.—The positive pole is to be placed in the cavity and the negative upon the cheek. The operator can quickly test for poles by placing the platinum point upon the negative salt-water pad. If there is a strong odor of chlorin and a bleaching effect under the point, the poles are correct; if not, they must be reversed. When using a battery for power, testing the polarity once will be sufficient. When the 110-volt current is used, however, owing to the polarity being occasionally reversed, this test should be made before each operation.

248. During the operation the cavity should be watched, and the cotton kept fully saturated with the solution. This should be added a very little at a time. Usually the amount that can be taken up in a capillary manner by the foil tweezers will be sufficient. If the cotton should be allowed to become dry, the resistance increases while the current decreases; then, if the cotton is filled with fresh solution, the sudden lowering of the resistance will cause a severe shock by the inrush of current. The operator can easily tell when the cavity is becoming dry by watching the ammeter. The index finger, which should always be traveling to the right with the increase of voltage, either stands still or drops back.

249. Increase of Voltage.—When beginning the administration of a current, the expression of the patient's face should be the guide as to the pressure that will be allowable. He should be instructed to give a sign on the first sensation from the current. If an automatic appliance is used for turning on the current, experience will very quickly teach the operator the rate that will be allowable in each case. If the current is to be increased by the operator or assistant, the rheostat should be stopped upon the first signal from the patient. After a few

seconds' rest the pain subsides and the current can again be increased under the same conditions as before. In this manner the current is gradually brought up until it ranges from 5 to 15 volts for sensitive dentin. The aim throughout should be to increase the voltage as rapidly as the patient will allow, for it is not until the last few minutes that effective infiltration is accomplished. As previously shown, most of the time is consumed in the first part of the operation; a minute at high pressure is equal to several at the beginning of the administration.

250. Turning Off the Current.—While it is necessary to turn on the current very slowly and gradually, turning off the current can be done rather rapidly. The electrodes should not be disconnected or the current turned off by a snap switch, for that will cause a severe shock, but the rheostat lever should be slowly turned back to the point of beginning. This step may take 5 or 10 seconds to produce no shock.

251. Length of Time Consumed.—The length of time consumed in a cataphoric administration on dentin depends on the pressure, the condition of the dentin, the area of exposed dentin, and the depth to which it is desired to penetrate. It would seem that the pressure is controlled entirely by the pain limit, and so it is. Herein lies the secret of shortening the length of time in cataphoric operations. When the operator fixes both electrodes and keeps the cavity constantly supplied with fresh solution, and is using an instrument that does not increase the current in perceptible steps, he can reach a high voltage much quicker than when the opposite conditions are present. It should be borne in mind that the depth of penetration in a given length of time is proportionate to the voltage. The last 2 minutes of the usual administration are more effective than the first 6, because of the much higher voltage that is reached at the close of the operation.

It is not within the power of the operator to modify the condition of the dentin, and the length of time, all other things being equal, will be inversely proportionate to the density. The dentin of children, and in those cases where the decay has been of rapid progress, will offer but little resistance to the

current, and the cocain will be carried in very quickly; whereas the dense dentin, which results from mechanical abrasion and from old age, will be penetrated with difficulty and a longer time will be necessary to effect complete anesthesia.

The extent of exposed dentin is, to some degree, a factor in determining the length of time. All things being equal, the larger the area of dentin exposed to the current the more pain will be felt if the pain limit is reached. In practice, the operator keeps just within the pain limit, and a very small cavity will permit of a higher pressure than a large one.

Another reason why a shorter time is required in the case of small cavities, is the less depth that is necessary for the preparation. As a rule, a small cavity usually requires less anchorage for a filling than a large one and, consequently, less depth of preparation. Thus, less time is required for those cavities whose area of exposed dentin is small, thus permitting the use of a comparatively high voltage.

In special cases, where it is desired to go to a considerable depth, the length of time will be prolonged; but not, however, in exact proportion to the depth. It seems that the nerve fibrils having been gradually brought up to a condition of numbness to the electric current, either by an advance effect of the anesthetic or by the toning effect of the current itself, they allow a higher voltage to be used than could be borne at first.

The average length of time that one should expect to give in dentin cataphoresis, with a good rheostat, will be about 8 minutes. In cases most favorable for a short length of time, only 5 minutes may be necessary; and in case of the opposite conditions, as long as 20 minutes may be required. Where a second application is necessary, it is usually found that the voltage can be raised more rapidly than was possible at the first application.

OTHER USES OF CATAPHORESIS.

252. The foregoing conditions and details have dealt mainly with cataphoresis for the treatment of sensitive dentin. Besides this, however, the dentist, being equipped with a cataphoric appliance, may use cataphoresis to advantage in

the removal of the pulp, lining the pulp canals with a metal or the salt of a metal, the extraction of teeth, opening into the antrum the excision of the apexes of the roots, bleaching, and in fact in the majority of instances where an anesthetic is hypodermically injected, or, as in the last instance, where it is desired to force a bleaching agent into the tissue.

In cases indicating the removal of a live pulp that is not fully exposed, a cataphoric application of cocain will oftentimes carry this agent to the apex of the root, and the pulp canal can be opened into and its contents removed without the least expression of pain. In cases in which the pulp is fully exposed, a comparatively short administration can be made with equally satisfactory results. It should not be understood, however successful cataphoresis may be upon sensitive dentin, that it is invariably so when used in the removal of the pulp, for there are cases in which, for some unaccountable reason, repeated applications have only met with partial success. In the majority of pulp cases, however, this method may be used with partial if not complete success. There will nearly always be enough good done to repay the attempt.

253. Cataphoresis in the Extraction of Teeth. Cataphoresis may be used to an advantage in the extraction of teeth, but in so doing a slight modification in the method of administration is necessary. Instead of using a pointed electrode, one must be used that will not only cover a large area over the roots, but to be effective, it should be applied to both sides at the same time. The S. S. White Company has placed such a device upon the market, which is shown in Fig. 72.

Within the rubber cups at the end is to be placed cotton saturated with the anesthetic, usually a 10-per-cent. solution of cocain. The length of time required is a little less than in dentin cataphoresis.

This method has several advantages over the hypodermic injection of cocain for this purpose. It is cleanly, and there is very little if any danger of septic poisoning, a patent fault of hypodermic needles. It is almost painless, at least much less

so than the needle method. It is comparatively safe from the dangers of cocain poisoning. There is no danger of bodily entering a vein, as sometimes happens when the solution is injected with a needle. The majority of the cases of cocain poisoning when administered by a needle were probably due

FIG. 72.
S. S. White Duplex Electrode for Extraction.

to the entrance of the charge into a vein, whence it is carried in a concentrated form direct to the heart and lungs, where it becomes effective.

254. A cataphoric application of cocain is of especial advantage prior to opening into the antrum or to the excision of the apex of a root. In both of these cases a topical application of cocain is frequently sufficient, but when accompanied by cataphoric assistance, it becomes a most reliable and satisfactory method. A double pad of new blotting-paper of the same size as the area to be anesthetized has been used, the pad being saturated with about a 30-per-cent. cocain solution. This is placed upon the mucous membrane, and an electrode about the size of a dime placed upon this, where it is held by the hand throughout the administration. The electrode may be held by the hand in this instance, because the mucous membrane is not so sensitive to the current as is the tooth pulp. From 3 to 5 minutes is usually sufficient in this class of cases.

255. Bleaching of Discolored Teeth.—At the same time that cataphoresis was introduced for the treatment of

sensitive dentin, it was also advocated for use in the bleaching of discolored teeth. Doctor Morton in the Dental Cosmos, of June, 1895, advocated the use of hydrogen peroxid for this purpose. Following that, various other agents were tried, which had formerly been used for the purpose, because of their well-known bleaching properties. Peroxid of sodium, chlorid of lime, and pyrozone especially, were all used cataphorically with equally good results.

In attempting to bleach a tooth in this manner the first step is the preparation of a suitably large opening on the lingual aspect of the tooth. This opening cannot be made too large, and especially in the lateral direction. The most perfect cases of bleaching are those in which a groove is cut on the lingual aspect of the tooth that will expose the full width of dentin. The current does not travel underneath the enamel, as has been shown, and for this reason the transverse cut should not be one that will expose all the dentin at its incisive edge.

The second step in the preparation of the tooth is the removal of all, or nearly all, the root filling, the object being to provide a path for the current. A pulp canal filled with gutta-percha will offer such a high resistance that it may be almost impossible to start the process.

FIG. 73.
Hollingsworth Tube Electrode

256. The instruments and electrodes used in bleaching have been especially devised for this purpose. The S. S White Manufacturing Company has placed a rather unique set of appliances for bleaching on the market, the invention of Dr. W. M. Hollingsworth. The first step after the preparation of

the transverse groove is the provision for holding the electrode and bleaching agent in position. A rubber nipple, shown in Fig. 73, has a hole cut in it of the usual size for slipping over a tooth. This is then expanded by means of the nipple expander shown in Fig. 74, and slipped over the tooth to be bleached. By a careful movement the expander can be

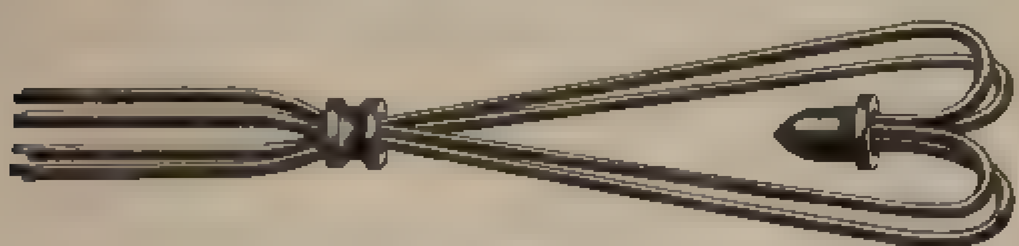

FIG. 74.
Nipple Expander

removed, leaving the rubber nipple tightly enclosing the tooth. It is not necessary to slip the nipple more than two-thirds the distance upon the tooth. This being accomplished, the special electrode, also shown in Fig. 73, is then slipped in the open mouth of the nipple.

The next step is that of filling the glass and nipple with the bleaching solution. For this purpose a special syringe, called a *duplex* syringe, and shown in Fig. 75, is to be used. The fine nozzle communicates with the second bulb. This is filled with the bleaching solution in the usual fashion. When the syringe

FIG. 75.
Duplex Syringe

is fitted into the electrode, the forward bulb being first compressed, is allowed to expand. This exhausts the air from the electrode and nipple, and a little pressure upon the rear bulb quickly fills the electrode with the solution. In this manner the electrode is kept constantly filled.

257. Solutions for Bleaching.—While a solution of sodium peroxid and the usual chlorin liberating agents in solution may be used, preference has been given to pyrozone when used in the Hollingsworth appliances. The ethereal solution of hydrogen peroxid is not a good conductor of electricity, and it must therefore be converted into an aqueous solution, which is done in the following manner: 1 part water to 2 parts of a 25-per-cent. pyrozone solution are held in an evaporating dish over a flame until the ether has evaporated. This leaves the hydrogen peroxid in an aqueous form and a good conductor of electricity.

258. The voltage and the amperage that one should expect to obtain in bleaching will vary much more than in dentin anesthesia, depending on the condition of the pulp canal and the resistance of the root portion. It needs scarcely be noted that a tooth that requires bleaching is a pulpless tooth to begin with. Teeth having lost their pulps will exhibit a very high electrical resistance, due to the loss of connection between the tubular contents and the tissues surrounding the apex of the root. Then, again, the pulp canal may be filled with a non-conducting material so that the only path that the current can find will be in a lateral direction through the dentin and cement of the root. It is obvious therefore that a larger portion of the root filling should be removed prior to making any attempt at forcing current through. At the beginning of the bleaching operation it may require as high as 60 volts to establish a path for the current. In the majority of cases, however, the requirements will seldom exceed 30 volts.

The amperage in bleaching cases will be little more, as a rule, than upon sensitive dentin. The tissues at the apex of the root or those that surround the root are not of the same highly organized structure as those that receives the first sting of the current in dentin anesthesia. They are not so sensitive to the current, and the operator may therefore use more current in bleaching than would be tolerated upon dentin. In this instance, 3 to 5 milliamperes would therefore be an average strength of current to be obtained.

259. The length of time consumed in bleaching will, like applications for sensitive dentin, depend on the condition of the dentin and the area of exposure. The operator in bleaching a tooth can, to a certain extent, tell by the appearance of the tooth how long he can profitably continue the application. In bleaching, however, the many widely differing conditions that will be present necessarily require a wide range of time. In favorable cases a tooth can be perfectly bleached in 8 minutes, and in others it may require 45 minutes to obtain a satisfactory result.

260. It may be that cataphoresis has fallen into disuse in late years, but this is probably due to the great amount of care that is necessary in every step to make this operation a success. There is no operation in dentistry, and especially upon dentin, in which there is required of the operator so broad a knowledge of electricity and such an amount of painstaking care as a successful cataphoric administration. In the first days of this method pulps were killed by carrying the process too far, gum tissue was destroyed by leakage, severe shocks were produced by suddenly breaking the current, and these, together with the amount of time consumed, have contributed to the partial abandonment of cataphoresis. Experience has shown that, however much care may be necessary for a successful cataphoric application, in some cases it is the best agent at the dentist's command. Dr. Louis Jack says: "When the pain attending excavation requires active treatment, such as the employment of zinc chlorid or general anesthesia, the cataphoric method is far preferable to either, and is absolutely certain of giving relief. The results of successful cataphoresis are marvelous, and it may be truly stated that no advance of recent years, in the therapeutic treatment of teeth, is comparable to this."

AN INDEPENDENT PLANT.

261. A Substitute for the Commercial Current. While the commercial applications of electricity are constantly increasing and the plants for meeting the growing demands are keeping pace with them, many dentists have no access to a commercial current. Moreover, the dentists in small towns that do have access to a commercial current usually find such a current to be either an alternating current of 52 or 104 volts, or the 500-volt current of a car line, neither of which is a suitable current for dental purposes. To meet all the dental requirements, a person in this position must establish an independent plant. At first thought this may appear to be a formidable undertaking, but it will be found to be entirely feasible, and one that will give a satisfactory return for the time and money invested.

262. Other Uses of the Plant.—An independent plant, such as will be described, while especially designed for dental purposes, will be found to be of use in many other ways. The majority of suburban dentists have their offices in their homes, and this plant will be of ample capacity to supply his living apartments with electricity that will be more than equal to a city current. He may use it for light, fans, cooking, charging an automobile, and, in fact, for more purposes than a single commercial current would be able to supply.

While the engine is charging a storage-battery, it may also operate the laundry, and many household utensils. In fact, the owner of such a plant will be surprised at the many applications that can be made of mechanical power in the household. The introduction of power and electricity in the country home is an innovation that is especially welcomed by the women of the household. The laundry washer and the electric iron may be operated either by the engine and dynamo direct, or by power from the storage-battery.

263. Charging Storage-Battery.—In the practical operation of such a plant, a given day, once or twice a week, should be set apart for charging the storage-battery, and the

other office and household operations should be arranged with this end in view. If, however, the storage-battery part of the plant is of large capacity, all the power and electrical applications can be made from that, irrespective of the operation of the engine.

APPARATUS CONSTITUTING AN INDEPENDENT PLANT.

264. An independent plant consists of an engine and dynamo, and to be complete and convenient, a storage-battery should also be used. A gas engine is used because of its small

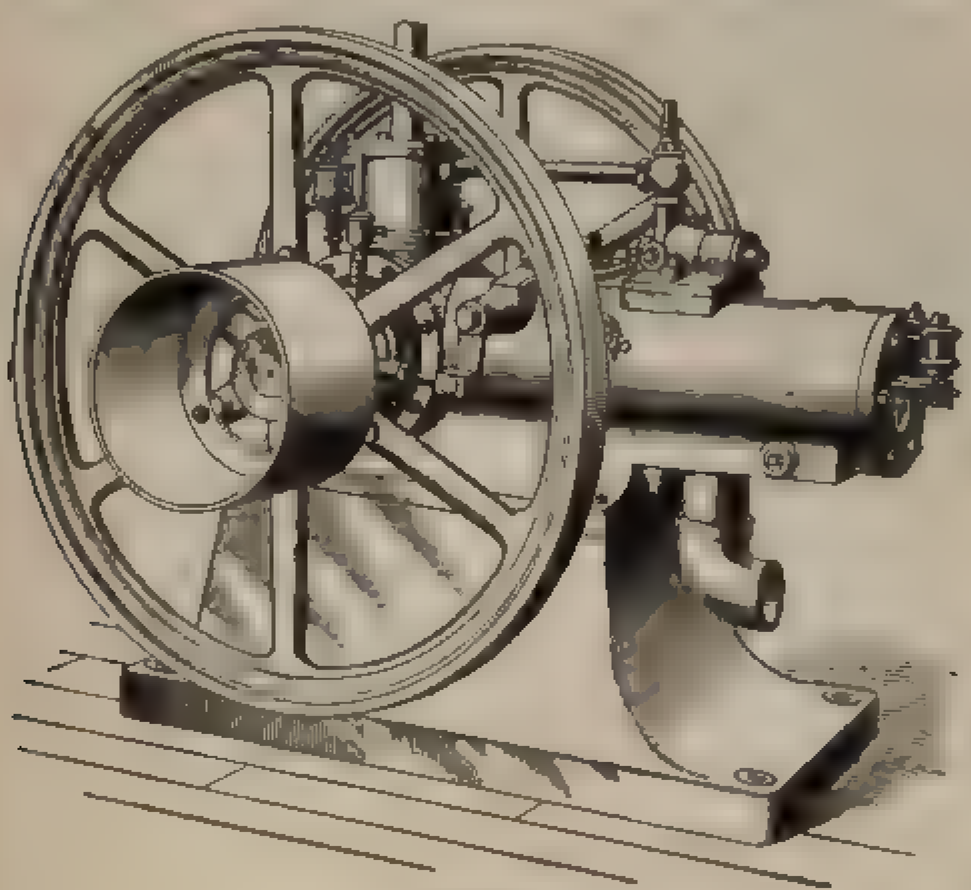

FIG. 76.
Horizontal Gas Engine.

size, low cost, and simplicity of operation. As a rule, most gas engines can be operated by gas or gasoline, interchangeably, so that if the dentist has not the one, he may use the other. As a matter of fact, although not quite so convenient, the output of a gas engine is considerably more when operated by gasoline than when operated by either natural or artificial gas.

GAS ENGINES.

265. There are two types of gas engines, the *horizontal* and the *upright*. The horizontal, as illustrated in Fig 76, has its cylinder in the horizontal position. This position is used in all large engines, and permits of perfect lubrication of the piston, which is an important feature The cylinder and bed is a single casting in the small sizes, and the latter is provided with holes for firmly bolting to the foundation.

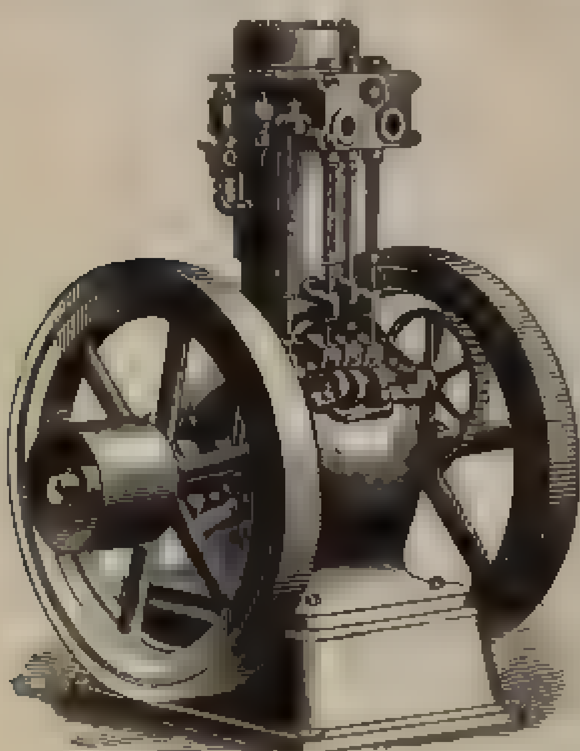

Fig. 77

Upright Gas Engine.

The upright engine, as shown in Fig. 77, has its cylinder in an upright position. This form is frequently used in engines of 10 horsepower, or less, and its principal advantage is the vertical motion of the reciprocating parts. Moreover, the jar of the explosion is received by the base in a downward direction upon the foundation, which reduces the motion of the engine to a minimum. No matter how well balanced a horizontal engine may be, there will always be some movement and jar from the explosion.

266. Principles of the Gas Engine.—The working principle is the same in both styles of engines, the principal difference being in the position in which the cylinder is placed. The motive power is given by the explosion of a gas, properly mixed with air. Every dentist has observed that if, in lighting the gas-burner under his vulcanizer, he does not introduce the flame before turning on the gas, a slight explosion will take place. The intensity of this explosion varies according to the proportions of air and gas. This is precisely what takes place

in the gas engine. Gas, or vaporized gasoline, properly mixed with air, is introduced into the cylinder, and this is ignited at the proper moment by an electric spark, or by the heat of the hot tube. The explosion takes place when the piston is at the bottom of the cylinder, and the force of the explosion drives the piston to the other end of the cylinder. This motion is communicated by the usual means of a connecting rod to the crank-shaft and balance-wheel. The cylinder of the gas engine has only one head. In a steam-engine the steam is introduced at both ends of the cylinder, but in the gas engine it enters only at the farther end. This allows very short coupling, and explains the compact construction of the gas engine, when compared with the steam-engine. The piston is usually one and one-half times as long as its diameter, in order that it may not cramp in the cylinder, when the connecting-rod is in its most angular position. In order that the cylinder may not get too hot, it is covered with an outer jacket, through which water is kept in constant circulation. In very small engines the cylinder is kept sufficiently cool, by outstanding ribs, which radiate the heat.

267. Method of Operation.—The mode of operation in most gas engines is as follows: Beginning with an outward stroke, the proper proportion of gas and air is drawn into the cylinder. On the return stroke, the gas is ignited just as the piston almost reaches the lower end of the cylinder. This is the moment at which the impulse is received, and the piston is driven out by the force of the explosion. On the return of the piston the burned gas is forced out through an exhaust port, which is opened by a cam appliance at the proper moment.

This completes the cycle, and it will be seen that the piston makes two complete out and in movements to each explosive impulse. In other words, the balance-wheels make two revolutions to one explosion in the process of taking in, exploding, and exhausting the gas. There are some engines, especially in the upright types, in which an explosion is produced with each outward stroke of the piston, but these are not the most efficient. The proportions of air and gas for the most powerful

explosions vary with the kind of gas used, but the average proportions are about 1 part of gas to 10 parts of air. If gasoline is used, a small jet of this is admitted through a needle valve into an air-chamber, where it volatilizes and mixes with the proper proportions of air.

268. Methods of Igniting the Gas.—There are two methods of igniting the gas, one by an electric spark, and the other by a hot tube. When the electric spark is used it is produced in two ways: One, by the simple opening of the circuit of an electric current, and the other by the use of an induction-coil, which causes the spark to jump from one point to another which is not quite in contact with it. If the contact method is used, two or three cells of the Edison-Lalande type are usually employed, and the current passes through a "spark-coil," which is simply a coil of rather heavy wire, wound around a bundle of soft-iron wires. The effect of the spark-coil is to cause the current to exhibit itself in a large spark when the circuit is broken. This is due to the induction effect caused by the soft-iron core of the coil. The jump spark is produced in the same manner that a spark is produced in a Ruhmkorff coil The terminals of the secondary are poised at a short distance from one another, and at the proper moment a spark is caused to pass between them.

The hot-tube method of ignition consists of a small tube, sealed at its outer end, and which communicates with the gas chamber, at its inner end. This tube is heated to a red heat at its outer end by means of a Bunsen burner. In the operation of the hot tube, the mixed gas is forced into this tube by the pressure caused by the piston as it reaches the inner end of the stroke. The length of the tube is so proportioned that the gas, in its compression, does not reach the igniting heat until the piston is about at the end of its stroke. When the proper proportions of gas and air are forced into this tube, they become ignited by its heat and the explosion takes place.

The exact moment of ignition is an important matter. In starting the engine the explosion should not occur until the crank has passed the dead center, but as the speed increases the

ignition should take place a little before the dead-center is reached. This is accomplished by shifting the position of the cam in the electric sparker, or by raising the heat of the tube when the hot tube is used.

269. Regulation of Gas Engine.—The regulation of gas engines is accomplished either by choking the supply of gas, or by entirely cutting off an occasional charge. The former is done by operating a wedge-shaped piece of metal under the gas valve from the governor on the engine. The method of regulating on the "hit-or-miss" plan is accomplished by a trip appliance that either opens the valve to the limit, or does not open it at all. The former method produces a more uniform speed of the engine, which is necessary when a dynamo is being operated.

270. Selection of Engine.—In selecting a gas engine for such a plant it should be a nominal 3-horsepower. The actual amount of work to be gotten from such a machine will seldom exceed 2-horsepower. There are but few gas engines that give the rated horsepower even under the most favorable conditions. Moreover, there are several reasons for having one as large as this. The actual electrical horsepower necessary for the heaviest requirements in dental practice is about two. By the time the mechanical energy of the gas engine has been converted into electrical energy through the dynamo, there will be but a small margin left. Moreover, a small gas engine is difficult to regulate, and when loaded to the limit it becomes very unsteady. This is especially noticeable if electric lamps are operated from the dynamo direct. The jar of the engine is very slight when it is not overloaded, thus tending to preserve its life and to make it a comparatively quiet piece of machinery.

271. Expense of Operation.—One might suppose that a large engine would be more expensive to operate than a smaller one, but it is a well-known fact that a small engine, which is overloaded, consumes more gas than a large one with the same load. For this reason there is no economy in using a small engine that is constantly working at its limit.

The cost of a 3-horsepower engine is but little more than that of a 2-horsepower engine. The usual prices are as follows: 1-horsepower, 100 dollars; 2-horsepower, 150 dollars; 3-horsepower, 175 dollars. There are some upright 3-horsepower engines, which are listed at 125 dollars, that give excellent results.

DYNAMO USED BY THE PLANT.

272. The dynamo of the plant should be a 15- or 20-light machine. This, if rated in "kilowatts," will be about a

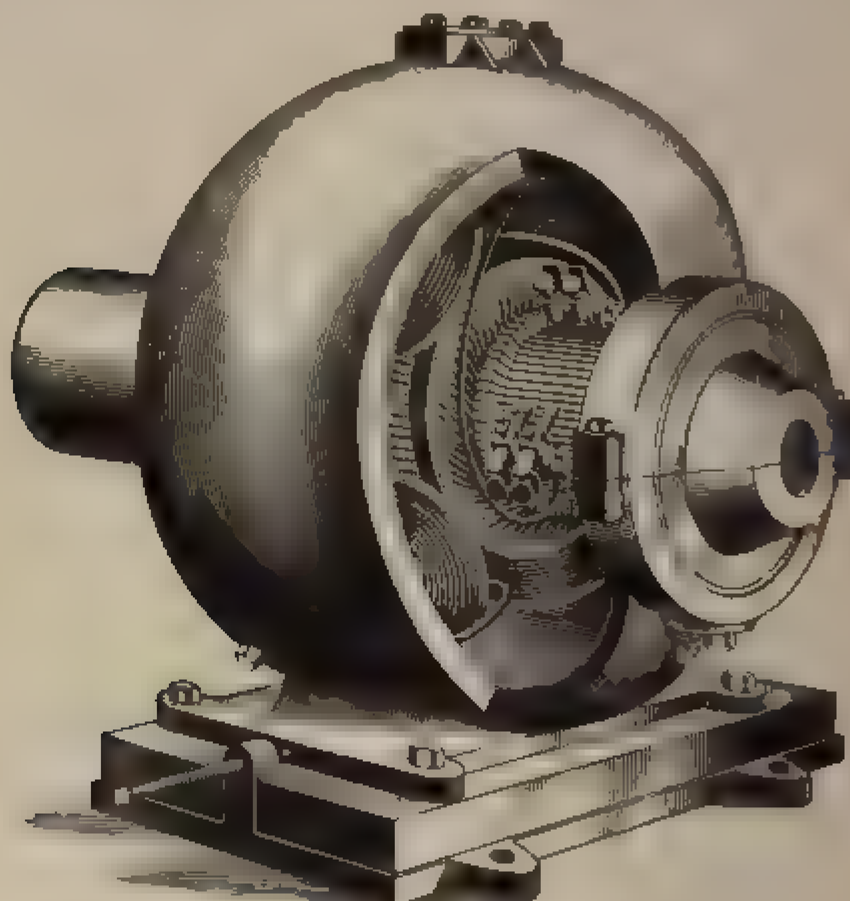

FIG. 78
Compound Wound Dynamo

1-kilowatt dynamo. It should be compound-wound for the purpose of compensating, to a small extent, for any unsteadiness in the gas engine, and also for the varying load that will be put upon it. The one illustrated in Fig. 78, made by Roth Brothers, of Chicago, is a compound-wound of 1 kilowatt capacity and costs 85 dollars. It is wound for 110 volts, which would be recommended for the following reasons: This voltage

is standard; it is the ideal dental current; the majority of dental instruments are designed for this voltage; and electrical fittings for it can always be had. This dynamo has given the best of satisfaction. Even when carrying 20 lights it does not heat to any appreciable extent. It can be made dust-proof by enclosing the ends with plates, which are made to fit the openings. The bearings are continually oiled by the ring device, so satisfactory in all large machines. The base is provided with a sliding device, whereby the dynamo can be easily moved for the purpose of tightening the belt.

273. Arrangement of Switchboard.—The switchboard of the plant should be arranged as shown in Fig. 79. Four wires will run from the dynamo to the board. Two of them will connect to the rheostat for regulating the voltage, while the other two will be the mains that first run through the fuse block, and then to the knife switch. The voltmeter, which is connected across the mains, as shown, is always necessary. The ammeter, while not a necessity, is a satisfactory instrument to have. This is placed in the series on one side of the main wires. It tells the exact amount of current that is being used, so that, in conjunction with the voltmeter, one can, at a glance, tell just what is the output of the plant.

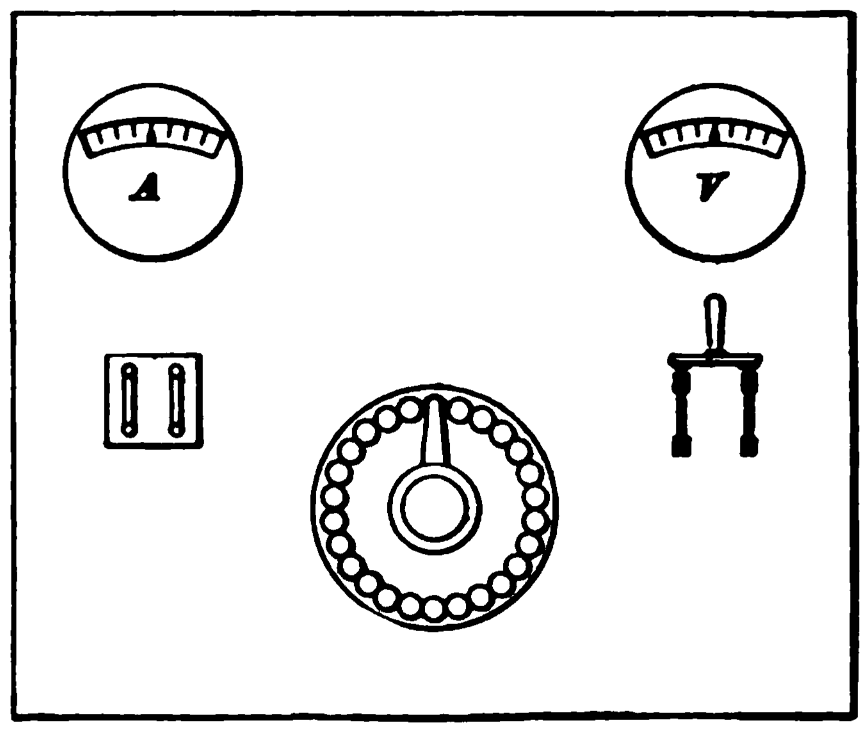

FIG. 79.
Switchboard.

274. Installing Generating Apparatus.—The gas engine and dynamo should be placed on the ground floor of the house or cellar, provided the latter is dry, or it may be placed in an outbuilding. If it should be in an inconvenient place the switchboard may be placed at any point in the house that will be convenient, for the dynamo can be regulated just as

well at some distance from it, as near by, it being only necessary to run four wires from the dynamo to the switchboard. The engine and dynamo may be in the cellar and the switchboard in the library. The starting of the engine can be done in a moment's time, and it requires no attention until it is to be shut off. This, also, can be done from the switchboard, if it should be necessary.

275. Adaptability of Storage-Batteries.—While the gas engine and dynamo are the necessary parts of an independent plant, such an arrangement will not be practical unless there is a constant use for current during its operation. In the practice of dentistry, hours sometimes elapse when no current is required, during which time there will be an unnecessary waste of energy. Frequently, also, there is a little use for the current for which it is impracticable to start the engine each time.

To meet this intermittent use of current, a supply should always be "on tap," as it were. To this end a storage-battery is necessary, and when once installed places the dentist in an independent position, and at the same time makes his plant a most practical venture.

The storage-battery should be one of 55 cells. These need be of only 30-ampere-hours' capacity. Such a battery will operate a 16-candlepower lamp for 60 hours, or ten such lamps for 6 hours, which will be sufficient to light a medium-sized house in the evenings for a week during summer months.

In the winter, however, about twice this amount will be consumed, and it will be necessary to operate the plant twice during the week. If the plant is to be operated at 55-volts pressure, then half the number of cells will be necessary, but they should be of twice the ampere capacity to give the same output. Thus, while there is little economy in the operation of a plant at this pressure, it is sometimes done in isolated plants intended for lighting purposes only, but where dental instruments are to be operated by it, the higher voltage is preferable.

276. High-Tension Cell for Operating Plant.—The type of storage-cell used for this purpose is not material, but in point of cheapness, the high-tension cell, can be recommended.

Four boxes of these trays will give 112 volts. Their simplicity of construction and compact bulk are desirable features. Moreover, when these cells are used it is just as economical to operate at 112 volts as at 55 volts. It is recommended, however, if the above type of cell is adopted, that the 40-ampere-hour cell be used rather than the 30-ampere-hour cell, for the reason that the first cost is but little more comparatively, the care is the same, the capacity is greater, and the life will be much prolonged.

277. Arrangement of Cells.—When these cells are set up, after the outside boxing is removed, they should be placed on a table or rack in such a manner that all the edges can be easily seen. The edges of the trays should be carefully separated, so that each will be equally distant from its neighbors. The electrolyte, consisting of 4 parts of rain-water to 1 part of commercial sulfuric acid, should be mixed in earthenware jars by adding the acid to the water. When this is cold, the absorbent material between each tray is to be filled until it will take up no more. The best method of doing this is to use a rubber syringe bulb with a hard-rubber point, such as can be found at the drug-stores. Acid should be added from time to time and in sufficient quantity to show around the edges. The trays must also be kept level, so as to insure complete covering of both sides of each plate, with the electrolyte.

278. Frequency of Charging Battery.—In the practical operation of the plant with the storage-battery, the dynamo should be operated at about 125 volts when charging the battery, and a current of about 10 amperes for the 40-ampere-hour cell will be sufficient. A battery of this size can be charged in half a day, and such a charge will last from 3 days to a week, according to the use put upon it.

If the dentist uses a laboratory, and an engine motor, a gold annealer, and the usual amount of light for his office, such a charge should last a week. If in addition he uses an electric oven, an air-compressor, and cautery, his battery will require charging twice a week.

A SERIES OF QUESTIONS

RELATING TO THE SUBJECTS
TREATED OF IN THIS VOLUME.

It will be noticed that the questions contained in the following pages are divided into sections corresponding to the sections of the text of the preceding pages, so that each section has a headline that is the same as the headline of the section to which the questions refer. No attempt should be made to answer any of the questions until the corresponding part of the text has been carefully studied.

Electricity in Diseases of the Eye, Ear, Nose, and Throat.

EXAMINATION QUESTIONS.

(1) In what portions of the auditory apparatus does electrotherapeutics find its chief utility?

(2) Why is the cathode of the direct current made the active electrode in the treatment of abnormal dryness of the external auditory canal?

(3) In stenosis of the external auditory canal, what is the indication for (*a*) cathodal electrolysis? (*b*) anodal electrolysis?

(4) State the indications for static sparks in diseases of the middle ear.

(5) Describe the electrotherapeutic treatment of tinnitus aurium when due to an abnormally dry condition of the nasopharynx.

(6) Describe the electrotherapeutic treatment of chronic rhinitis.

(7) What are the complications that occasionally follow this treatment, and what should be done to prevent them?

(8) What is the object aimed at in the treatment of hypertrophic catarrh, and how is this object best accomplished?

(9) Describe the electrotherapeutic treatment of hypertrophies located (*a*) anteriorly; (*b*) posteriorly.

cribe the electrolytic treatment of hypertrophied masses.

(11) How would you treat ulcers found beneath crusts in le atrophic catarrh?

Describe the technique of cupric electrolysis in the ment of ozena.

(13) Of what service is the electrocautery in the treatment ay-fever?

4) When malignant f the nasal cavities has ed a stage where radical s are impracticable or are ned by the patient, what sources has the operator at his command?

5) What two methods are recommended for the removal asal polypi?

How is the cautery-snare adapted to a sessile growth?

(17) How is the danger of hemorrhage obviated in removing sessile growths by the electrocautery-snare?

(18) (*a*) What agent affords the most favorable results in the treatment of septal spurs? (*b*) Describe the technique of its application.

(19) Describe the electrotherapeutic treatment of epistaxis when due to ulceration?

(20) What are the essentials of treatment in clergyman's sore throat, and how are these best brought about?

(21) What effect has the age of a patient on the details of the operation for removing hypertrophied tonsils, and what method of operating is recommended (*a*) in young children? (*b*) in adults?

(22) Describe the electrotherapeutic treatment of chronic follicular tonsillitis.

(23) Describe the method of Bordier for treating stricture of the Eustachian tube.

(24) What are the objections to the use of the cautery in diseases of the larynx?

(25) (*a*) Describe the technique of cupric cataphoresis in tuberculosis of the larynx. (*b*) State its advantages over the cautery, curette, and electrolysis.

(26) (*a*) State the uses of the electrocautery in diseases of the larynx. (*b*) Give the technique of its application in these conditions.

(27) What constitutes the best treatment of stenosis of the larynx?

(28) What should be the composition of electrolytic needles?

(29) Describe the method of removing offending hairs in trichiasis.

(30) In electrolyzing a rodent ulcer, state (*a*) the pole used; (*b*) current-intensity; (*c*) duration of current-flow; (*d*) place of insertion of electrolytic needle.

(31) In treating chalazion, (*a*) which pole is made active? (*b*) what current-strength is employed? (*c*) what is the duration of current-flow? and (*d*) how often is the treatment repeated?

(32) Describe the process of electrolyzing vascular nævi of the lids.

(33) Describe the use of the electrocautery in entropion and ectropion.

(34) Which do you consider the most valuable of all therapeutic agents in the treatment of lacrimal stenosis?

(35) Describe the technique of the operation for lacrimal stenosis.

(12) How may electrolysis be made caustic in its action?

(13) What is the best apparatus for the preliminary exploration of an urethra supposed to be strictured?

(14) Describe the armamentarium necessary in the treatment of urethral stricture.

(15) Describe Newman's urethral electrodes.

(16) In what does the art of successfully applying electrolysis consist?

(17) Is it advisable to apply electrolysis on the same day that the first examination is made?

(18) What size electrode is usually selected in beginning the electrolytic treatment of stricture of the urethra?

(19) What current-strength suffices in the majority of cases of stricture?

(20) If there is more than one stricture, what is the method of procedure?

(21) Should force ever be used in the electrolytic treatment of stricture of the urethra?

(22) What is the usual length of each séance?

(23) If pain occurs during electrolytic treatment of strictures of the urethra, what does it indicate?

(24) How many instruments are passed during each séance?

(25) How often is the operation of electrolysis repeated?

(26) Is the result produced by electrolysis in the treatment of stricture due to absorption or to dilatation?

(27) What is the effect of negative galvanism on spasmodic action, and what current should be employed to overcome this condition?

(28) State the advantages of electrolysis in the treatment of urethral stricture.

(29) To what is failure in the electrolytic treatment of stricture of the urethra to be attributed?

(30) What qualifications should the operator have in order to successfully treat stricture of the urethra by electrolysis?

(31) What is the objection to anesthesia in electrolyzing a stricture?

(32) Describe Doctor Fort's operation.

(33) State the objections to internal urethrotomy.

(34) Describe the electrolytic treatment of urethritis chronica glandularis.

(35) Describe the technique of electrolytic treatment of stricture of the esophagus.

(36) State (*a*) the current-strength used, (*b*) the duration of each séance, and (*c*) when séances may be repeated, in cases of esophageal stricture.

(37) What may be said of the success of electrolysis in treating stricture of the rectum?

(38) Describe (*a*) the armamentarium necessary in the electrolytic treatment of stricture of the rectum, and (*b*) the technique of the operation.

(39) Of what service is electrolysis in malignant stricture of the rectum?

(40) Describe the electric treatment of prolapsus ani.

(41) Describe Newman's method of treating hypertrophy of the prostate with the electrocautery sound.

(42) State the important factors in Bottini's operation.

(43) How many incisions are usually made in Bottini's operation, and which incision is the most important?

(44) Under what condition is the anterior incision employed, and what is its danger?

(45) On what does the length of the incision depend?

(46) When the prostate is soft and compressible, what is the usual length of incision?

(47) Under what conditions are long incisions recommended?

(48) On what do the results of Bottini's operation for prostatic hypertrophy depend?

(49) When is it recommended that the Bottini operation be done?

(50) State the complications that may occur during Bottini's operation, and how they are best prevented.

(51) State the post-operative complications.

(52) Describe the technique of iodin cataphoresis in the treatment of hypertrophy of the prostate.

Therapeutics of Static Electricity.

EXAMINATION QUESTIONS.

(1) (*a*) What may be said of the use of static electricity in the treatment of diabetes mellitus? (*b*) How does static electricity influence the prognosis and the comfort of the patient?

(2) In the treatment of diabetes insipidus, how may blisters be substituted to advantage?

(3) (*a*) How may an acute attack of gout be aborted? Describe the treatment fully. (*b*) How often should these electrical treatments be repeated?

(4) Of what use is static electricity for treating the chronic state when the acute attack has been aborted?

(5) Where does muscular rheumatism chiefly localize itself?

(6) What forms of treatment are especially recommended by therapeutic textbooks for muscular rheumatism?

(7) Describe the static methods used in the treatment of muscular rheumatism.

(8) What is the prognosis of muscular rheumatism when static methods are employed?

(9) What should be the posture of the patient during a static application for muscular rheumatism?

(10) What measures constitute the therapeutics of chronic articular rheumatism?

(11) State the static methods employed in the treatment of chronic articular rheumatism.

(12) State the first indication in the treatment of gonorrheal arthritis.

(13) The source of infection being removed, what are the indications for static electricity in the treatment of gonorrheal arthritis?

(14) State the chief symptoms of arthritis deformans.

(15) Has static electricity any place in the treatment of arthritis deformans?

(16) State the chief indications for the treatment of obesity.

(17) How is static electricity utilized in the treatment of obesity, and what special benefit is derived from its use?

(18) How may deposits of fat be locally treated by static currents?

(19) (*a*) At what period in the course of infectious diseases does static electricity prove a beneficial agent? (*b*) What forms of static electricity are used, and what is the action desired?

(20) What may be said of the importance of the use of static electricity in influenza?

(21) (*a*) In the treatment of chronic dysentery, what static methods are especially indicated? (*b*) Where is the counter-irritant spray applied?

(22) What are the chief indications in the treatment of hay-fever?

(23) Describe the static application for the dyspnœa of hay-fever patients.

(24) (*a*) Describe the method of treatment of chronic laryngitis and pharyngitis by Leyden jar currents. (*b*) How often should the application be repeated?

(25) Describe the static application for the relief of pleuritis.

(26) What are the two chief indications in the treatment of asthma?

(27) What static methods are employed in the treatment of asthma?

(28) Are organic diseases of the heart directly treated by static electricity?

(29) (*a*) What relation does static electricity bear to the pathology of organic diseases of the heart? (*b*) State the indications for static treatment in these conditions.

(30) State the two chief considerations in the treatment of diseases of the blood-vessels by static currents.

(31) Describe the treatment of exophthalmic goiter by static methods.

(32) In the treatment of diseases of the eye and ear, what are the indications for static methods?

(33) For the relief and cure of constipation, what static methods are employed?

(34) How does the physiologial action of static electricity on nerve- and muscle-tissue differ from that of galvanic currents?

(35) (*a*) Into how many classes may nervous diseases be divided with reference to treatment by static electricity? (*b*) What other classification may be made?

(36) State the use of static currents in the treatment of epilepsy.

(37) What benefit is derived from static applications in the treatment of chronic myelitis?

(38) (*a*) What static methods are employed to relieve the numbness, impaired sensation, and sense of weight in the lower extremities in locomotor ataxia? (*b*) Is the relief afforded by this method of treatment permanent?

(39) Which is the chief remedial agent in the treatment of progressive muscular atrophy?

(40) (*a*) What is the most important therapeutic agent in the treatment of anterior poliomyelitis? (*b*) At what period of life does this disease generally occur? (*c*) State briefly the action of static sparks in this condition.

(41) What are the two chief requirements in the treatment of hysteria minor?

(42) What are the two indications in the treatment of hysteria major?

(43) In what conditions is the prognosis of hysteria major unfavorable?

(44) State the three types of neurasthenia, and the age at which they are most likely to occur.

(45) What are the four different pathological conditions in which neurasthenia may arise?

(46) What is the most important feature in the treatment of neurasthenia?

(47) What headaches are not amenable to static methods?

(48) In the treatment of megrim, (*a*) what may be said of static methods? (*b*) what are the indications for static sparks?

(49) What may be said of the indications for the use of static electricity in sciatica?

(50) When static treatment fails to give relief in case of neuralgia, what does it indicate?

(51) What static methods are employed in the treatment of neuralgia?

(52) Define writers' cramp.

(53) How do rest and drug therapeutics rank in the treatment of this condition?

(54) Describe, briefly, static applications employed in the treatment of writers' cramp.

(55) Considering the relation of static electricity to paralysis of all kinds, what two pathological facts should the physician bear in mind?

(56) What five questions are necessary to remember in the therapeutic consideration of any case of paralysis, with reference to static electricity, regardless of the cause?

(57) When is the galvanic current to be preferred to the static current in the treatment of neuritis?

(58) What governs the prognosis of these cases?

(59) What part has static electricity in meeting the requirements of improving nutrition, and giving symptomatic and palliative relief in Bright's disease?

(60) What may be said of the uses of static electricity in gynecology?

(61) Can the functions of the skin be modified by static methods?

(62) Explain how static electricity produces nutritional and functional modifications in diseases of the skin.

ELECTRICITY IN DENTISTRY.

EXAMINATION QUESTIONS.

(1) What are the essential conditions permitting electrolytic action?

(2) How did Arrhenius explain the process of electrolysis and in what does his theory differ from that of Grotthuss?

(3) In what two ways is electrolysis put to practical use by the electrotherapeutist?

(4) What apparatus is necessary for electrolytic medication in dentistry?

(5) State the uses of an electroplating outfit in dental work.

(6) What will take place if a piece of clean iron is dipped in a solution of copper sulfate?

(7) What are the objections to this method of electroplating?

(8) What current is used for electroplating and how may it be obtained?

(9) State the maximum voltage used in electroplating in dental work.

(10) How many volts are required to deposit (*a*) copper from its solution? (*b*) nickel from its solution?

(11) Describe and illustrate the electrical arrangement for adapting the 110-volt current to electroplating work.

(12) How is a dynamo used in electroplating wound, and why is it wound in that way?

(13) What may be said of the necessity for cleanliness in electroplating?

(14) What care is necessary in preparing the surfaces of articles for plating?

(15) Describe the chemical preparation of copper, brass, and German silver before plating.

(16) Describe the process of plating a non-metallic object.

(17) In the process of gold-plating, state (*a*) voltage used; (*b*) composition and size of anode.

(18) What difficulties are encountered in plating with platinum and how are they overcome?

(19) Describe the preparation of a surface for silver-plating.

(20) What may be said of the uses of copper in electroplating?

(21) Describe the method of copper-plating small articles.

(22) How is copper amalgam produced?

(23) In the process of nickel-plating, state (*a*) voltage used; (*b*) composition and size of anode; (*c*) precautions to be observed.

(24) On what does the finishing of all plated objects depend?

(25) Should the object to be plated be placed in the bath before or after the current is turned on, and why?

(26) Should the voltage be high or low at first?

(27) Define cataphoresis.

(28) On what does the success of cataphoresis in dentistry depend?

(29) State the objections to the Edison current in dental work and how they may be overcome.

(30) What battery is used for cataphoric work?

(31) What constitute the foundation for a successful cataphoric operation?

(32) On what does the current-strength of a cataphoric operation depend?

(33) Describe the outfit used for cataphoric applications.

(34) What determines the depth and quantity of cataphoric action?

(35) What is the effect of the size of the cavity on the milliampere strength of current used?

(36) What caused the loss of gum-tissue in the early operations of cataphoresis, and how is this accident prevented?

(37) What is the average milliampere strength in cataphoresis?

(38) When the milliammeter registers more than this what does it indicate?

(39) What determines the amperage that one should expect in each case?

(40) Of what service is the voltmeter in cataphoric applications?

(41) What influence has the position of the negative electrode on the meter reading, and where should the negative electrode be placed in cataphoric operations?

(42) What metal is used as the anode in dentin cataphoresis?

(43) Describe the method of Doctor Price for dentin cataphoresis.

(44) What is the first and most necessary step in cataphoresis for sensitive dentin?

(45) How should metal fillings that are likely to be reached by the cocain solution be treated?

(46) What is the second step in dentin cataphoresis?

(47) Why should the cotton be kept fully saturated with the cocain solution, and how is this accomplished?

(48) How can the operator tell when the cavity is becoming dry?

(49) What is the guide to the voltage that will be allowable?

(50) On what does the duration of cataphoresis for sensitive dentin depend?

(51) What controls the voltage in a cataphoric application?

(52) What is the average length of time required in dentin cataphoresis?

(53) State the uses of cataphoresis in dentistry other than for the treatment of sensitive dentin.

(54) Describe cataphoresis when used in the extraction of teeth.

(55) Describe a cataphoric application of cocain prior to opening the antrum or to the excision of the apex of a tooth.

(56) Describe the technique for the bleaching of discolored teeth by cataphoresis.

(57) On what does the length of time consumed in bleaching depend?

(58) In a favorable case, what is the duration of treatment?

(59) To meet all dental requirements, when the Edison current is not accessible, what resource is left to the dentist?

(60) What apparatus are comprised in an independent plant?

(61) How many types of gas engines are there and on what, does the operation of a gas engine depend?

(62) What is the horsepower of a gas engine necessary to run an independent plant?

(63) Describe the dynamo of this plant.

(64) Illustrate and describe the arrangement of the switchboard.

(65) Of what service is the storage-battery?

(66) State (*a*) the number of cells in a storage-battery; (*b*) the tension of the cells; (*c*) the ampere-hour capacity of the battery; (*d*) the electrolyte of the cells; (*e*) the frequency of charging the battery; (*f*) the care of the battery.

(67) What is the principle of the characteristics of electricity?

(68) Mention some other characteristics of electricity that adapt it so well to dental work.

(69) What advantages has the electric light over other forms of light?

(70) State the advantages of electric heat over other forms of heat in its use in the dental office.

(71) State the advantages of electric power over other forms of power utilized in dental practice.

(72) What may be said of the care necessary for electrical appliances in a dentist's office?

(73) Are the dentist and his patient perfectly safe when using commercial currents when proper precautions have been taken?

(74) Describe the construction of a mouth-lamp.

(75) When a mouth-lamp is used on a commercial circuit, what precaution should be taken?

(76) State the two most important applications of electric heat in dentistry.

(77) On what two factors does the production of heat by electricity depend?

(78) What are the objections to the flame for annealing gold?

(79) Describe the electric annealer.

(80) State the advantages of the electric annealer.

(81) Describe the construction of the electric oven.

(82) State the objections to the old-style oven.

(83) State the five essential points of the electric oven.

(84) What are the advantages of the electric oven?

(85) What are the advantages of a rheostat in circuit with an electric oven?

(86) How is facility afforded for observing the fusing process in the electric oven?

(87) Describe the care of the Custer electric oven.

(88) How is the electric oven repaired?

(89) How may the alternating current be adapted to cautery work in dental practice?

(90) Describe the Custer warm-water appliance.

(91) Describe the method of fusing platinum (*a*) by the time process; (*b*) by the carbon process.

(92) State the value of motors in dental work.

(93) How may the dental engines of today be classified?

(94) How can a treadle engine be converted into an electric engine?

(95) Describe the best method of installing motor and lathe.

(96) Why should the first button of a rheostat be blank?

(97) Describe and illustrate the reversing switch for (*a*) a series-wound motor; (*b*) a shunt-wound motor.

(98) What is the ideal fan for the dental chair?

(99) What properties has an electric mallet that are not possessed by other mallets?

(100) How are the patient and the chair insulated from water-pipes and gas-pipes when electrical instruments are to be operated by a commercial current?

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All items in this index refer first to the section number,—which is printed on the inside edges of the headlines and is preceded by the printers' section mark §,—and then to the page number. Thus, Agitans, Paralysis 20 57, means find the paper having § 20 on the headlines and then find page 57.

D.

F.

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